The FOUNDRY

Volume 47. No. 14
Whole No. 330

Published
Semimonthly

CLEVELAND, OHIO, SEPTEMBER 1, 1919

Unsoundness in Aluminum Castings

Results of Experiments on Porosity and Unsoundness of No. 12 Alloy of Aluminum —Blowholes Are Function of Pouring Temperature, Time Metal is Held in Furnace, and Other Factors

By ROBERT J. ANDERSON

THE study of defects in nonferrous metals and alloys is still in a very backward condition as compared with iron and steel; in aluminum, systematic researches, utilizing the principles of physical metallurgy, have begun only in the last few years. The most common light aluminum alloy used in the United States for the production of castings is that one known in foundry circles as No. 12, composed, roughly, of 92 per cent aluminum and 8 per cent copper.

This paper is published by the permission of the director of the United States bureau of mines. It is an extract in part from a forthcoming publication of the bureau. The author, Robert J. Anderson, is metallurgist, bureau of mines, experiment station, Pittsburgh. All of the specimens illustrated, Figs. 3 to 24 inclusive, except Fig. 23, were etched with NaOH.

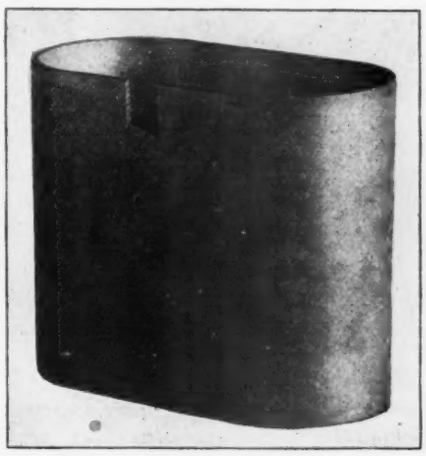


FIG. 1—FORM OF THIN SHELLS POURED IN THE CASTING EXPERIMENTS

This alloy, or others of a similar composition, is employed for a wide variety of castings, and aluminum founders are doubtless more familiar with it than any other. Aluminum founders have long recognized that pouring temperature is a cogent factor in influencing the strength of castings, but not a great deal of stress has yet been laid upon soundness and the factors affecting it. Some engineers and founders appear to hold the opinion that mere lightness, i. e., low specific gravity, is a paramount virtue of aluminum-alloy castings; as a matter of fact, however, what is really wanted are light, strong, sound castings. There are, of course, difficulties imposed by the kind of alloys

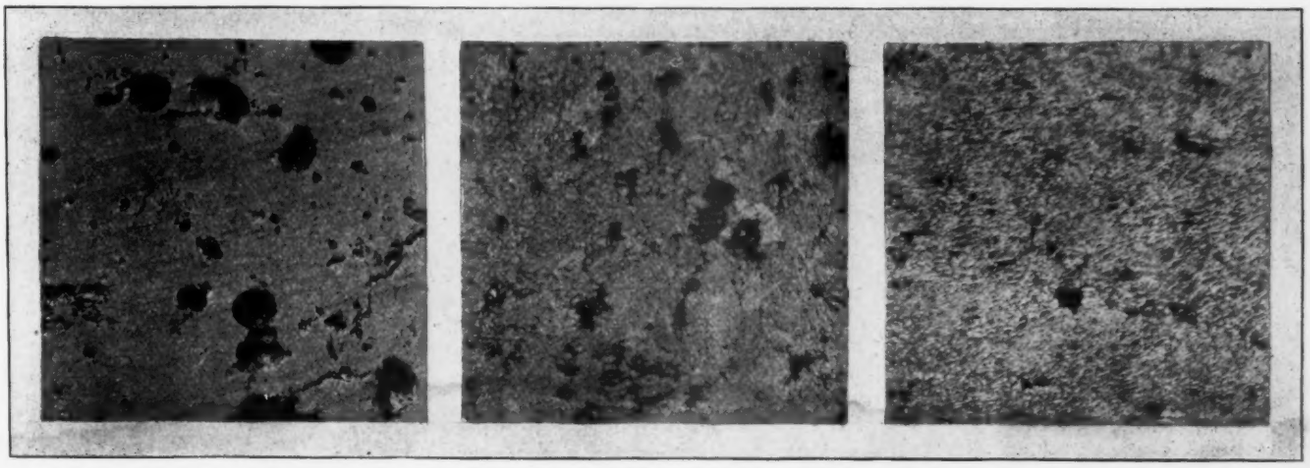


FIG. 2—BLOW HOLES AND GENERAL UNSOUNDNESS IN 92:8 A1-CU ALLOY UNETCHED; FROM CRANK CASE; 5 DIAMETERS FIG. 3—UNSOUNDNESS IN 92:8 A1-CU ALLOY FROM CRANK CASE SHOWING SEEPAGE IN OPEN GASOLINE TEST; 7 DIAMETERS FIG. 4—UNSOUNDNESS AND BLOW HOLES IN 92:8 A1-CU POURED AT 640 DEGREES CENT.; 7 DIAMETERS

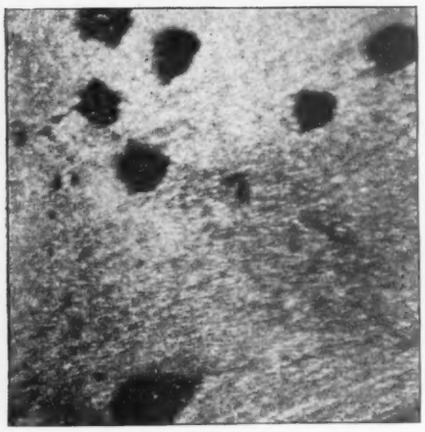


FIG. 5—UNSOUNDNESS AND POROSITY IN 92:8 AL-CU ALLOY POURED AT 950 DEGREES CENT.; 7 DIAMETERS

used as well as by the design of the castings, the molding practice, and the method of melting, but the ideal should be to turn out the best possible castings within the limitations imposed.

In connection with the studies now being made by the bureau of mines in the metallurgy of aluminum, consideration has been given to the general subject of blowholes, porosity, and unsoundness in the 92:8 aluminum-copper alloy. The total results of the studies already made and contemplated are not yet in hand, but there are, at this time, available some data regarding the influence of pouring temperature and length of melting period on blowholes and unsoundness. The results of the completed studies will appear later in the form of a bureau of mines publication under the title, "Blowholes, Porosity and Unsoundness in Aluminum-Alloy Castings."

That unsoundness in sand-cast aluminum alloys is no myth, but a matter of serious importance is generally recognized by the light alloy industry. Porosity in castings that must meet the open gasoline test or stand hydraulic pressure constitutes a serious defect to manufacturers of motor car and aircraft castings.

Practically all aluminum-alloy castings ever made have been more or less unsound; this statement can readily be verified by examining polished microsections of samples taken at random. Typical examples are shown in Figs. 2 and 3, where the former is a macrograph at five diameters of a section cut from a crankcase and the latter a macrograph at seven diameters of a section cut from a portion of another crankcase showing seepage in the open gasoline test. These are not exaggerated examples at all, and more or less similar results can be observed by examining almost any casting. The conclusion should not be drawn that all aluminum-alloy castings are totally unsound throughout all parts; the term unsoundness is only relative at best. In a complicated casting, some portions will be likely to be more unsound than others, but at the present writing unsoundness would appear to be presupposed in connection with aluminum-alloy castings. Some tests have been made in connection with the present work for the purpose of studying the effect of pouring temperature on the soundness of the 92:8 aluminum-copper alloy and also the effect of time of melting on the same property. In the tests about to be described, confirmatory evidence of already known facts has been obtained and some new data have been made available.

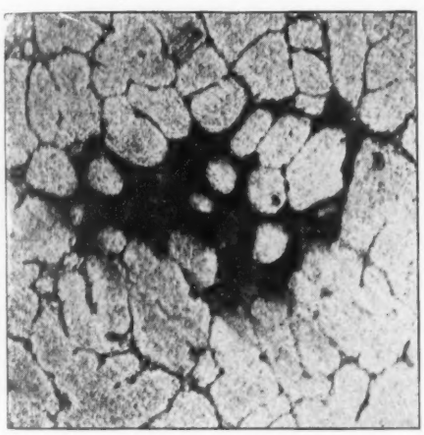


FIG. 7—SAME AS FIG. 6, BUT SHOWING UNSOUNDNESS; 75 DIAMETERS

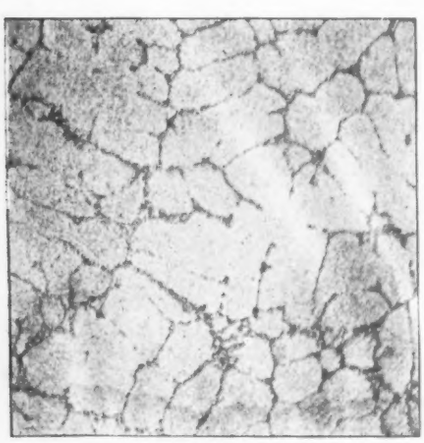


FIG. 6—HEAT *A*, POURED AT 650 DEGREES, FROM THE BAR, AVERAGE STRUCTURE, SOUND PORTION; 75 DIAMETERS

The present article will not deal at all, except to mention it, with the influence of furnace atmosphere on the properties of aluminum alloys, but that is a question which merits serious consideration by metallurgists and one that seemingly has been given entirely too little attention. The question of the solubility of gases in aluminum and the formation of loose compounds at elevated temperatures is one that apparently has considerable importance, and studies in this direction should prove fruitful. However, only the briefest mention of these matters can be made now. Various elaborate methods, in the case of steel, have been perfected for the prevention of blowholes, and it would not appear to be straining analogy to say that a consideration of the many methods in vogue for preventing unsoundness in steel might possibly prove of value in studying the same defect in aluminum-alloy castings.

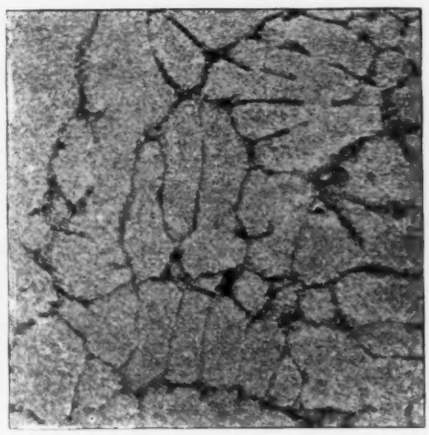


FIG. 8—HEAT *B*, POURED AT 850 DEGREES, FROM THE BAR, AVERAGE STRUCTURE, SOUND PORTION; 75 DIAMETERS

In the preliminary tests made in connection with the present work, small heats of about 25 pounds each of the 92:8 aluminum-copper alloy were made up. The heats were charged as follows: The requisite amount of 50:50 aluminum-copper rich alloy was first melted down in plumbago-clay crucible, using a gas-fired furnace; when the rich alloy had melted, enough virgin aluminum ingot, in the form of three-pound, six-notch bars, together with about 10 per cent of No. 12 gates and risers

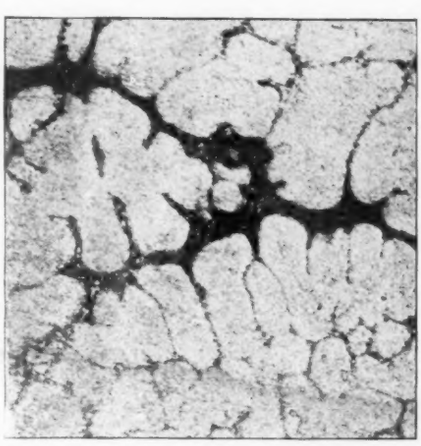


FIG. 9—SAME AS FIG. 8, BUT SHOWING INTERGRANULAR UNSOUNDNESS; 75 DIAMETERS

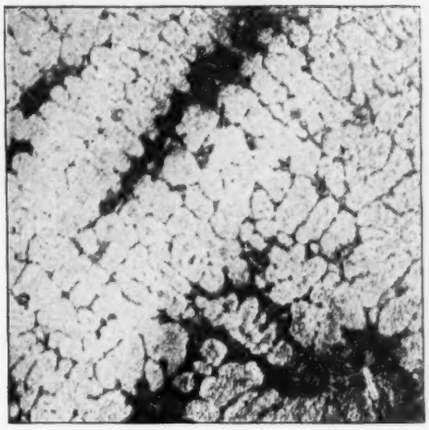


FIG. 10—HEAT *B*, POURED AT 850 DEGREES CENT. FROM THE BAR, AVERAGE STRUCNESS; 75 DIAMETERS

were added to make up the heat. Six sets of castings were poured, and the essential information is summarized in Table I. The castings were simply thin shells as shown in Fig. 1, the dimensions being roughly 7⅝ by 6 by 4⅛ inches and ⅛-inch thick. The cut-out portion is the place from which a microsection was taken for microscopy. Two kinds of castings were poured from the first six heats: (1) the thin shells, and (2) bars, 0.75-inch square by 12 inches long. The shells are hereafter referred to as castings and the bars as bars. Castings of different thicknesses were thus poured for the purpose of ascertaining whether any exaggeration of defects might be traced to size of section under otherwise identical conditions. The castings were poured in ordinary sand molds properly rammed and vented; each thin shell was poured in a single mold and its companion bar in another separate mold. In the first six heats, the influence of pouring temperature and length of time in melting on soundness was observed. Duplicate runs, in which the data

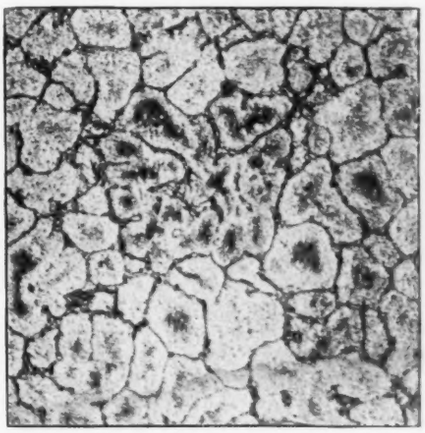


FIG. 11—HEAT *C*, POURED AT 630 DEGREES CENT. FROM THE BAR, AVERAGE STRUCTURE, SOUND PORTION; 75 DIAMETERS

were practically the same as shown in Table I, were made for checking purposes. The average chemical composition of the first set of six castings and bars was copper 7.62 per cent, iron 0.39 per cent, silicon 0.26 per cent, and aluminum 91.73 per cent by difference.

Additional Tests

Additional tests on the effect of pouring temperature alone on unsoundness were performed by making up 60-pound heats of the 92:8 aluminum-copper alloy, in the manner described, and pouring 1.50-inch square by 12 inches long bars, at 50 degrees Cent. intervals as shown in Table II. Duplicate runs were made for the purpose of checking.

In the tests summarized in Table II, a charge of 60 pounds was heated rapidly to 975-1000 degrees Cent.; the crucible was then removed from the furnace, and bars were poured at

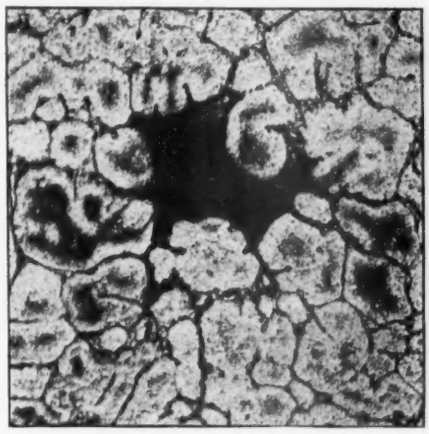


FIG. 12—SAME AS FIG. 11, BUT SHOWING UNSOUNDNESS; 75 DIAMETERS

50 degrees Cent. intervals from the same pot by allowing the melt to cool between pours. The range of pouring temperature, as indicated in Table II, was from 950 to 650 degrees Cent. The average chemical composition of a composite sample of the 1.50-inch square bars was copper 7.55 per cent, iron 0.36 per cent, silicon 0.29 per cent, and aluminum 91.80 per cent by difference. In connection with these tests, some interesting information on the contraction of the No. 12 alloy was furnished by examination of the frozen pouring gates, and this will be dealt with in a later paragraph. The resultant castings and bars, referred to as *A* to *M* inclusive were examined for surface appearance and microscopically for general characteristics and unsoundness. Polished microsections of both castings and bars were examined macroscopically and machined surfaces were examined for blowholes. All temperatures in the

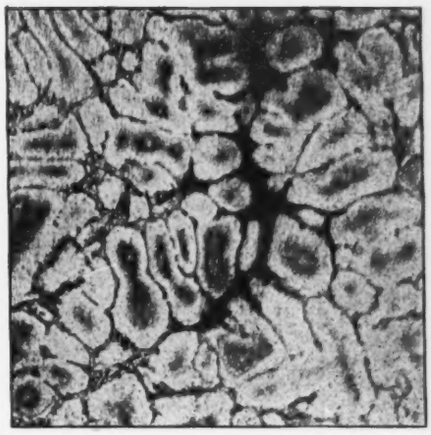


FIG. 13—HEAT *D*, POURED AT 640 DEGREES CENT., FROM THE BAR, UNSOUNDNESS; 75 DIAMETERS

above experiments were taken with a base-metal thermocouple of the pyod type which was calibrated to insure its accuracy.

The castings and bars poured in heats *A* to *M* inclusive were examined macroscopically and microscopically for blowholes, porosity, and general unsoundness. In examining castings for relative unsoundness, this defect can best be judged by simply inspecting polished or machined surfaces. Microscopic examination is not so useful. In the present experiments, the bars cast from the various heats were machined smoothly by milling, and the surfaces were inspected for holes. Microsections from the bars and castings were also prepared and studied. It has been previously stated that soundness in aluminum-alloy castings is a relative term at best and that all castings are more or less porous. Hence, the term "soundness" should not be regarded as absolute but as roughly descriptive. Figures 4 and 5 are indicative of what a macrograph can show as regards soundness. The former shows the surface appearance of a microsection cut from a 0.75-inch square bar cast

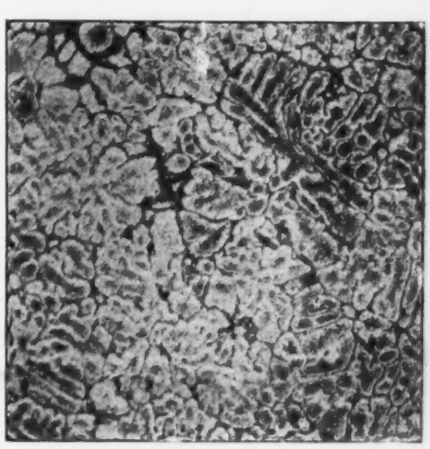


FIG. 14—HEAT *D*, POURED AT 640 DEGREES CENT., FROM THE CASTING, AVERAGE STRUCTURE, SOUND PORTION.

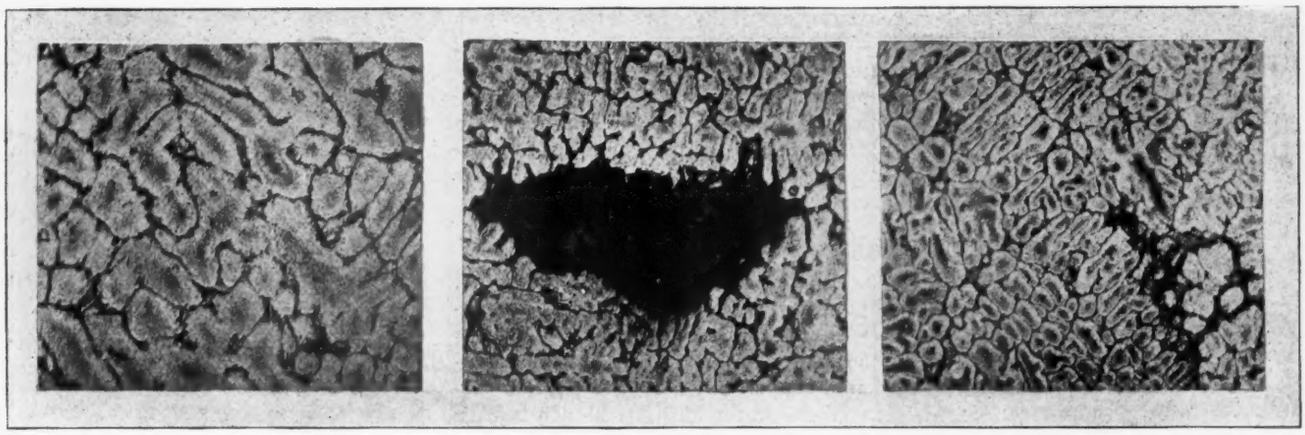


FIG. 15—HEAT *E*, POURED AT 950 DEGREES CENT., FROM THE BAR, AVERAGE STRUCTURE, SOUND PORTION; 75 DIAMETERS FIG. 16—HEAT *E*, POURED AT 950 DEGREES FROM THE CASTING, UNSOUNDNESS; 75 DIAMETERS FIG. 17—HEAT *F*, POURED AT 700 DEGREES CENT., FROM THE CASTING, AVERAGE STRUCTURE, SOUND PORTION; 75 DIAMETERS

from heat *D*; the latter is a similar macrograph from heat *E*. Heat *D* was poured at 640 degrees Cent., and heat *E* at 950 degrees Cent. Machined surfaces also show relative unsoundness fairly satisfactorily. Macrographs on samples from heats *G* to *M*, inclusive, proved extremely instructive and a few of these are reproduced in Figs. 19 to 22 and Fig. 24, inclusive. In general, the number of blowholes per unit area in a casting increases with increasing pouring temperature. Fig. 24, from heat *M* poured at 650 degrees Cent., shows no holes at all, but many holes may be seen in Figs. 19, 20 and 21.

A detailed elucidation of the micrographs in Figs. 6 to 18, inclusive, may prove interesting. It may be noticed in comparing the microstructures of the 0.75-inch bars and the ⅛-inch thick castings, that in the former the grain size is much larger than in the latter. This is, of course, to be expected since the thin casting is chilled much more rapidly by the sand than a thick one; a thick casting may even exhaust the thermal capacity of a sand mold, before it freezes, provided conditions are conducive to that end. The micrographs give evidence of at least three kinds of unsoundness: (1) That which is plainly intergranular and may be due to an actual forcing apart of the grains by gas attempting to find an

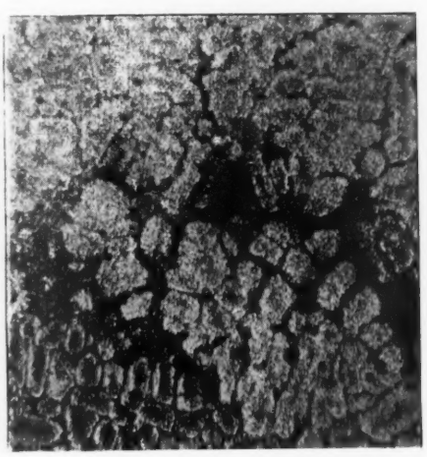


FIG. 18—SAME AS FIG. 17, BUT SHOWING UNSOUNDNESS; 100 DIAMETERS

exit to freedom, or to intergranular occluded foreign matter which is a source of weakness at best and in effect results in unsoundness; (2) that due to actual liberation of gas which is entrapped at the moment of final freezing; and (3) that which is the result of a balled-up oxide occluded in quite large gobs, in an indiscriminate fashion in the frozen alloy. Intergranular occluded foreign matter, whether oxide or what not, is well shown by Figs. 9 and 13, while unsoundness due to the third cause mentioned is illustrated by Fig. 16 Actual blowholes or holes from which occluded foreign matter has dropped on polishing are shown in the low power illustrations in Figs. 19, 20 and 21.

The proposal has been made by Wheeler P. Davey and others, and actually carried out in some instances, that X-ray photographs of castings would prove useful in determining the soundness of castings. In fact, Tonamy (Jour. Inst. Metals, vol. 14, 1915, pp. 200-203) proposed to decide by radiographs whether or not certain copper castings were worth machining. Now some machine shop scrap is the result of finding undue porosity and blowholes after taking a few cuts with a milling machine, for example, in machining aluminum-alloy motor castings. In connection

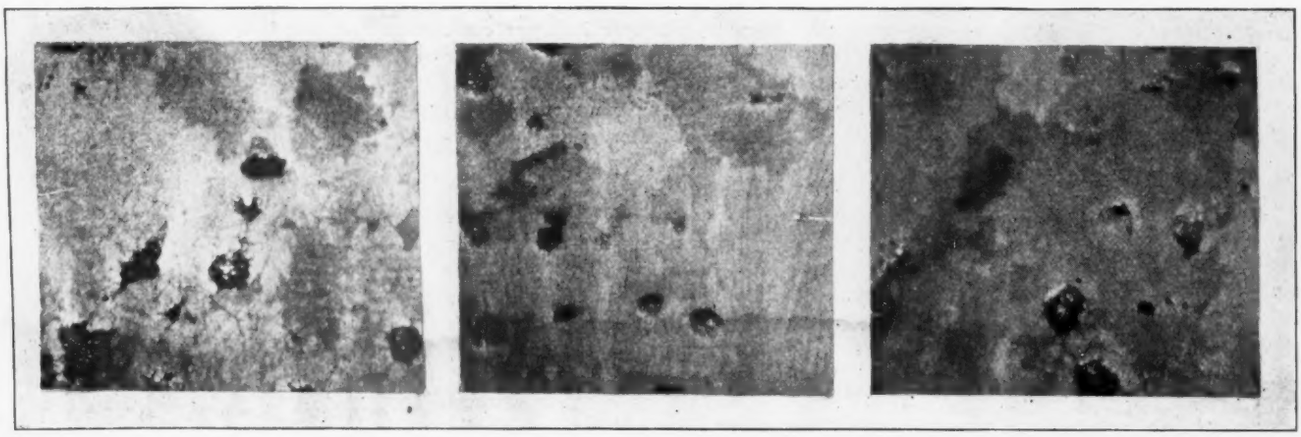


FIG. 19—HEAT *G*, POURED AT 950 DEGREES; 7 DIAMETERS FIG. 20—HEAT *H*, POURED AT 900 DEGREES; 7 DIAMETERS FIG. 21—HEAT *J*, POURED AT 800 DEGREES; 7 DIAMETERS

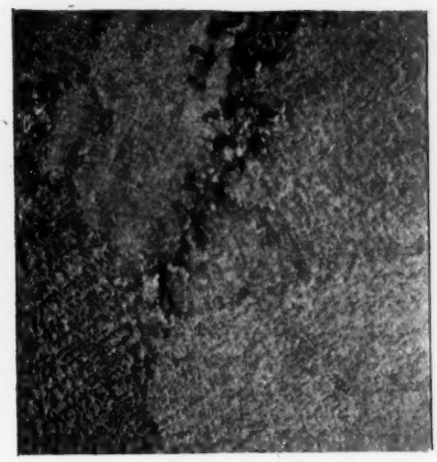


FIG. 22—HEAT L, POURED AT 700 DEGREES; 7 DIAMETERS

Table I

Influence of Pouring Temperature and Length of Time of Melting

Heat	Treatment	Pouring temperature Degress Cent.	Remarks applying to appearance of castings.
A	Heated the charge to 650 degrees Cent. and poured at once.	650	White, good, smooth appearance.
B	Heated the charge rapidly to 860 degrees Cent. and poured at once.	850	Tinted with oxidation stains; rough appearance; many surface holes.
C	Heated the charge rapidly to 880 degrees Cent., removed from furnace and cooled to 630 degrees Cent.	630	White, fair appearance; cold shut.
D	Heated the charge to 650 degrees Cent., and held in the furnace for one hour at 650-720 degrees Cent.	640	White, fair appearance; cold shut not so marked as in C.
E	Heated the charge rapidly to 900 degrees Cent. and held in the furnace for one hour at 900-950 degrees Cent.	950	Oxidation stains; bad looking casting; rough; many surface holes.
F	Heated the charge rapidly to 900 degrees Cent., held in the furnace for one hour at 900-950 degrees Cent.; removed from furnace and cooled to 700 degrees Cent.	700	White, fairly good surface appearance.

(a) Duplicate runs of 25-pound charges were heated in a gas-fired furnace.
(b) Average chemical composition was, copper 7.62 per cent; iron, 0.39 per cent; silicon, 0.26 per cent; and aluminum, by difference, 91.73 per cent.

Table II

Metal from the Same Charge Poured at Different Temperatures

Heat	Pouring temperature Degrees Cent.	Remarks applying to appearance of castings
G	950	Soundness, surface appearance and color varies with the pouring temperature.
H	900	
I	850	
J	800	
K	750	
L	700	
M	650	

(a) Duplicate runs of 60-pound charges were heated in a gas-fired furnace to 975-1000 degrees Cent., the crucible was then removed from the furnaces and bars were poured at 50 degrees Cent. intervals.
(b) Average chemical composition was, copper 7.55 per cent; iron, 0.36 per cent; silicon, 0.29 per cent; and aluminum, by difference, 91.80 per cent.

with the tests described, it was the thought that possibly an X-ray examination would be of assistance in locating the presence of internal blowholes as well as general porosity and sponginess, without cutting the suspected samples and polishing as in metallography. Some radiographs were made of flat plates, 0.25-inch thick, and of bars, 1-inch square. Samples of each were deliberately made porous by pouring at a high temperature in a damp mold, and radiographs on these were compared with radiographs on fairly sound samples correctly poured.

An X-ray tube with a tungsten target was used for radiography. A few radiographs were made on very porous samples obtained from various aluminum foundries. The results of the X-ray work would indicate that this apparatus is of no particular use (for practical purposes) in detecting internal blowholes. In complicated castings, suitable radiographs would entail considerable difficulty in preparation and probably a large number of radiographs would have to be taken on any given casting to decide whether it was worth machining or not. From the practical standpoint, it is difficult to see how the X-ray examination of aluminum-alloy castings has any application at the present time. Actually, it will simplify matters greatly from the machine-shop standpoint to make the castings sound in the first place in the foundry. Also, it may not be altogether out of place to suggest here that it will be foundry economy to produce finished castings on the foundry floor rather than to try to patch them by

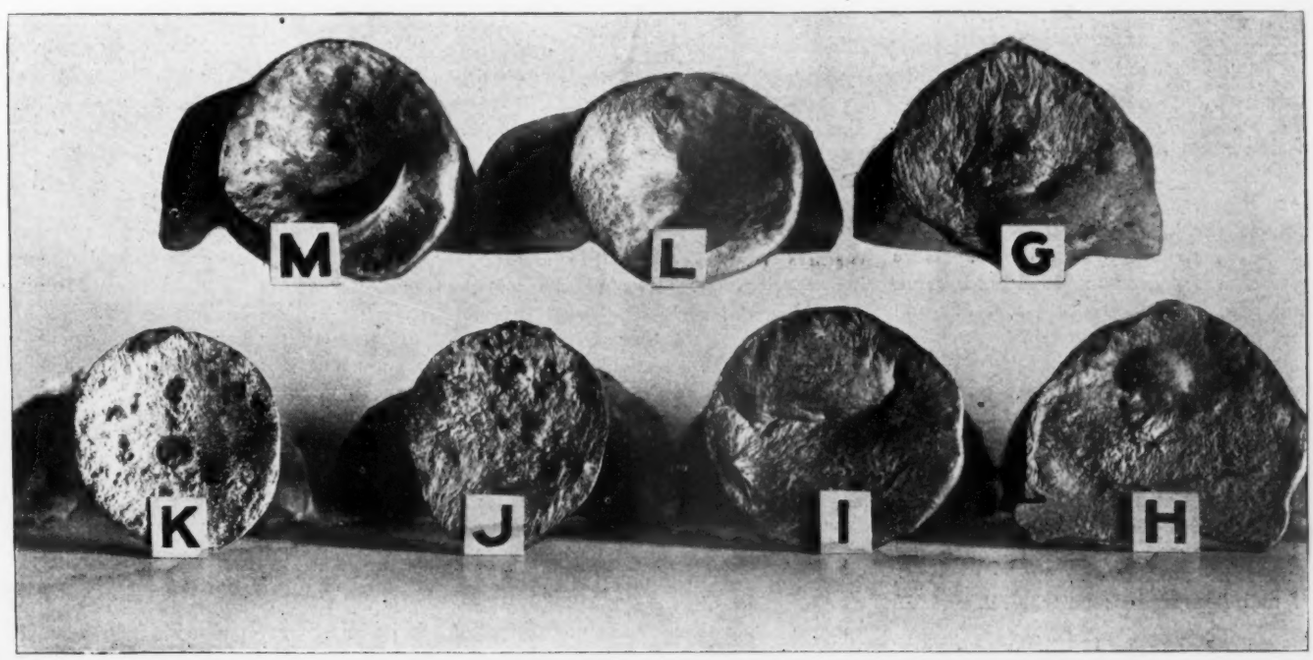


FIG. 23—EXPANSION AND CONTRACTION IN 92-8 ALUMINUM COPPER ALLOY. HALF SIZE

later welding and otherwise doping.

Turner suggested a supposed expansion of aluminum some years ago, but Chamberlain (Journ. Inst. Metals, vol. 10, 1913, pp. 193-234) in referring to Turner's work stated that the apparent expansion could be accounted for by dissolved gases in the metal. A striking example of the effect of various factors on the contraction of the 92:8 aluminum-copper alloy was shown in the present work in the heads of the pouring gates of the series of bars cast at 50 degrees Cent. intervals, namely, heats *G* to *M*, inclusive. The amount of contraction is a function of the pouring temperature, so far as the limitations of the experiments can show, but whether it is also, and at the same time, connected with dissolved gases is not certain. It is a fact, however,

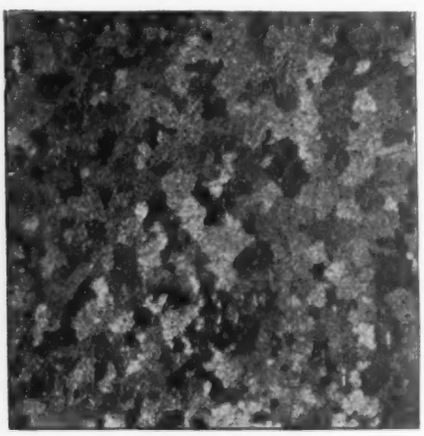


FIG. 24—HEAT *M*, POURED AT 650 DEGREES; 7 DIAMETERS

that a casting poured at 950 degrees Cent. contains more dissolved gases at the moment of pouring than another similar one poured at 650 degrees Cent. The greater solubility of gases in liquid metals with increasing temperatures is a departure from the general laws governing solutions of gases in aqueous liquids.

The effect of temperature, or dissolved gases, or both, on the contraction of the 92:8 aluminum-copper alloy is shown strikingly by Fig. 23. Here gate *G* was poured at 950 degrees Cent. and gate *M* at 650 degrees Cent., and the others at 50 degrees Cent. intervals as indicated in Table II. Gate *G* actually expanded while the shrinkage in gate *M* is marked and apparently normal. Gradations in degrees of expansion and contraction are shown in the other gates depending on the pouring temperature. Gate *J*, poured at 800 degrees Cent., apparently did not contract or expand much; gates *G*, *H* and *I* expanded; gates *K*, *L* and *M* contracted.

It has been hinted that the solubility of gases in aluminum is a cogent factor in governing blowholes, porosity and contraction. This is an important study in connection with the production of aluminum-alloy castings, but only the briefest mention can be made regarding this now. Aluminum metallurgists, however, will doubtless find that a consideration of this question will furnish interpretable data that can be applied to the solution of foundry difficulties in connection with melting practice.

The conclusions drawn from an examination of the rough castings, of machined surfaces of the bars, and of polished microssections cut from both castings and bars are these:

A.—The number of blowholes present in a function of the pouring temperature; the higher the pouring temperature, the greater the number of blowholes and the more unsound is the casting.

B.—Unsoundness varies with the temperature to which the charge was heated; the higher the temperature in the furnace, the more unsound the resultant castings are, irrespective of the pouring temperature.

C.—Unsoundness is a function of the length of time of melting; the longer any melt is held in the furnace, the more unsound are the castings, irrespective of the temperature of heating and the pouring temperature.

It can be readily seen that the factors affecting the soundness of castings can influence one another either favorably or adversely. Thus, pouring an overheated melt at a lower temperature by allowing the charge to cool prior to pouring will aid in minimizing the deleterious effects of overheating. Castings poured at low temperatures are more sound than those poured at high temperatures, but heats held in the furnace for a long time at either high or low temperatures are more unsound than those held for a short time. The most aggravated cases of unsoundness will result from pouring a melt at a high temperature which has previously been grossly overheated and for a long time. There is nothing to lead to the belief that there is a minimum temperature below which it is not safe to go for fear of unsound castings resulting from too low pouring temperature. The results of the experimental heats and also past foundry experience, together with the general information available, would lead to the conclusions that with the methods of melting now in vogue, the heats should be kept at a low temperature in the furnace; melting should be as rapid as possible, i. e., the charge should be poured as soon as it is melted; and the pouring temperature should be so low as is consistent with the metal filling the mold. This means nothing other than close supervision of melting and pouring, together with a study of the appropriate correlation between the molding floor and the furnace room. It will be best to have the molding floor waiting for metal rather than have the furnace room waiting for molds. Close pyrometric control is also presupposed in actual foundry production.

Malleable Iron Burned by Too Much Air

By H. E. Diller

Question: We have been getting good malleable iron with a tensile strength of approximately 50,000 pounds per square inch, but at present the iron smokes as it comes from the furnace and the castings are honeycombed. We melt a charge in 3 hours and 10 minutes. We charge at 1.30 per cent silicon and get iron with 0.47 per cent silicon and 1.80 per cent carbon. The brown smoke comes from the metal before it is hot enough to pour so I do not see how it can be burnt.

We are using fuel oil. How much should be required to melt a ton of metal?

Answer: There is no doubt but that you are burning your iron by using an excess of air. The amount of air should be cut down and you should not try to melt your iron so fast. Oxidation of the metal also burns out silicon and carbon. The silicon should not be reduced more than 0.25 per cent. The more carbon you burn out the higher you must heat the iron in order to get it to run properly. This in turn tends to burn out more carbon.

Iron will burn with a large excess of air even before it is hot enough to pour. An extreme illustration of this is the burning of steel with the oxy-acetylene flame. In this process the edge of the steel is heated with the flame, then an excess of oxygen is turned on and this cuts the cold steel by burning it.

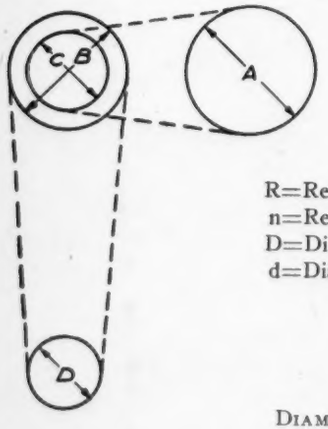
You should be able to melt your iron using 35 gallons of oil to the ton.

Artificial Molding Sand

W. J. Nelson, president and general manager of the West Albany Molding Sand Co., West Albany, N. Y., announces that after 10 years spent in trying out different processes he has developed an artificial sand which can be made on a commercial basis. The advantages claimed for this sand are that it is bonded so that it will withstand the flow of the metal without cutting, but contains no excess bonding material; it is uniform and of the proper size to allow the gases to escape without being too course, and it is free from vegetation which would develop gas when burned by the hot metal, thus eliminating one trouble.

DATA ON BELTS AND PULLEYS

By W. L. Tryon



Revolutions Per Minute of Driven Pulleys

The number of revolutions per minute of a driven pulley is equal to the product of the revolutions per minute of the driving pulley and the diameter of the driving pulley divided by the diameter of the driven pulley. Or where

R=Revolutions per minute of the driven pulley.
n=Revolutions per minute of the driving pulley.
D=Diameter of the driven pulley.
d=Diameter of the driving pulley.

$$R=\frac{d\ n}{D}$$

Diameters of Driven Pulleys

The diameter of a driven pulley is equal to the product of the revolutions per minutes of the driving pulley and the diameter of driving pulley divided by the revolutions per minute of driven pulley.

$$D=\frac{d\ n}{R}$$

Diameters of Driving Pulleys

The diameter of a driving pulley is equal to the product of the diameter of driven pulley and revolutions per minute of driven pulley divided by revolutions per minute of driving pulley.

$$d=\frac{D\ R}{n}$$

Revolutions Per Minute of Driving Pulley

The number of revolutions per minute of a driving pulley is equal to the product of the diameter of driven pulley and the revolutions per minute of driven pulley divided by the diameter of driving pulley.

$$n=\frac{D\ R}{d}$$

(*Continued on Data Sheet No.* 300)

DATA ON BELTS AND PULLEYS

By W. L. Tryon

(*Continued from Data Sheet No.* 299)

Revolutions Per Minute of Driven Pulley in Compound Drive

The number of revolutions per minute of the second driven pulley is equal to the product of the revolutions of the first driving pulley and the quotient obtained by dividing the product of diameters of driving pulleys by the product of diameters of driven pulleys. Or where,

A and B=Diameters of the driving pulleys.
C and D=Diameters of the driven pulleys.
N=Revolutions per minute of second driven pulley.
n=Revolutions per minute of first driving pulley.

$$N=\frac{n\ A\ B}{C\ D}$$

Pulley Diameters in Compound Drive

Place the revolutions per minute of the driving pulley as the numerator of a fraction and the revolutions per minute of the driven pulley as the denominator, and reduce this fraction to its lowest terms. Then resolve both numerator and denominator into two factors and multiply each pair of factors (that is one in the denominator and one in the numerator) by a number which will give pulleys of large enough diameter.

Example: The number of revolutions per minute of A=320 per minute.
The number of revolutions per minute of D=900 per minute.

$$\text{Fraction}=\frac{320}{900}=\frac{16}{45}\quad\text{resolve into factors}\quad\frac{8\times 2}{9\times 5}$$

$$\text{Multiplying pairs by same numbers}=\frac{(8\times 1)\times(2\times 4)}{(9\times 1)\times(5\times 4)}$$

$$\text{or}\ \frac{8\times 8}{9\times 20}$$

∴ 8 and 8 are diameters of driven pulleys C and D and 9 and 20 are diameters of driving pulleys.

(*Continued on Data Sheet No.* 301)

THE FOUNDRY DATA SHEET, SEPTEMBER 1, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

Electric Furnace Improves Gray Iron

Duplex Process of Melting in a Cupola and Finishing in an Electric Furnace is Advocated for Certain Classes of Gray-Iron Castings Where Quality is the First Requisite

By GEORGE K. ELLIOTT

THE central facts and fancies embodied in this paper are either taken from or inspired by divers experiences with a basic-bottom Heroult electric furnace at the plant of the Lunkenheimer Co., Cincinnati. Inasmuch as these experiences extended over a period of nearly two years, and as the electric furnace is presented in a service different from usual, the author feels that his subject, at least, is justified by both a reasonably ample observation and a certain novelty of matter.

The growth of the electric furnace in the field of steel castings has been widespread and irresistible; but, so far, the homely gray-iron casting has been beneath its exalted attention. Or, is it that the cupola furnace, venerable and efficient to a remarkable degree, has been a citadel too mighty to be overwhelmed by the invasion of the electric furnace, as were the established furnaces of the steel foundries? However it may be the author believes the electric furnace has a very fair chance to break through into the domain of iron castings, at points in the line where the hammering of modern engineering for supergrades of castings is rapidly effecting a perceptible breach.

Classes Requiring Special Iron

In regard to gray-iron castings, it cannot be denied that today there are classes of castings for which the insistent demand is for physical properties of a higher order than are commonly characteristic of such iron. Possibly every branch of engineering has some castings that should be, and sooner or later may have to be, made of better gray iron than is now used. One case, and the direct cause of the experiences here related, is that of steam valves for high-pressure and superheated steam. Both pressures and temperatures of the steam used in power plants have passed through a period of exceptional growth, placing upon the apparatus for handling steam severer demands than ever before. Similar is the case of cylinders for locomotives using superheated steam. Also there is the case of cylinders for internal combustion engines.

The two prime qualities most generally wanted in high-grade gray cast iron are strength and solidity, properties which usually are concurrent. The best strength gray iron shows is when under compression, and its worst, under impact and vibration; between come transverse strains and tension. If the cases are studied in which unusual strength of iron is required, it is discovered that almost always the castings are to be used where they will be subjected to either impact, vibration or tension; or, in fact, where cast iron is at its greatest disadvantage.

Solidity Defined

Under the head of solidity may be included a number of related items such as density, closeness of grain and freedom from subcutaneous imperfections such as slag inclusions, graphite segregations, blow-holes, shrink-holes, and the like. Solidity is an excellent goal for the aspiring foundryman; but, in going after high specific gravity he has to beware that he is not lured out from the realm of true gray iron into the dangerous domain of mottled and white irons where brittleness lurks to impair the impact strength of castings, and hardness to ruin their machinability.

Strong irons without exception require high pouring temperatures because they have high melting points and minimum fluidity. The irons most easily melted and, consequently, the most fluid ones, have high percentages of phosphorus in their make-up. Medium and high phosphorus irons comprise by far the greatest part of the melt of the gray-iron foundries of the country. They are the popular casting irons; and it is no extravagance to say that phosphorus has done as much or even more than any other element to popularize gray iron for castings. Still, phosphorus has the grave fault of unfavorably affecting the strength of iron, a thing it accomplishes by forming in the iron mass a network of structurally free phosphide which is quite brittle. Although easily fluid, high phosphorus irons are brittle and generally lacking in strength; conversely, tenacious, strong irons are necessarily low in percentage of phosphorus contained. The well known fact that strength and fluidity do not go hand in hand brings to light the greatest defect of the cupola furnace—its thermal limitations. It is the foundryman casting strong iron who knows best these limitations. The complete melting operation as it takes place in any furnace is divided into three obvious stages—preheating, melting proper, and superheating. For the first two, the cupola is the furnace preeminent; but for superheating it is not the same paragon of excellence.

All ordinary grades of gray iron—those with medium and high percentages of phosphorus—cannot be melted more easily or more economically than in the cupola. For melting efficiency this furnace takes precedence over its two closest rivals—the reverberatory or air-furnace, and the regenerative open-hearth furnace. For simplicity of construction, low cost of installation and upkeep, ease of operation, and economy of melting, it has no real competitor; and there is no probability that, for the great run of ordinary gray-iron castings, it ever will be displaced, although its improvement is conceivable. From the standpoint of process alone, no fault can be found with the cupola; but, from the high ground of product, it shows defects. The two worst of these are its weakness as a superheater for molten iron, and its incapacity as a refiner. The cupola is not a refining furnace and sometimes its hottest possible iron is not hot enough for the best casting results to be secured.

Hotter Iron is Obtained

The thermal limitations of the cupola are inflexible and often tenacity has to pay the price of fluidity. If the demand for supertenacious and solid iron also becomes inflexible, there arises a dilemma which is capable of but one solution, and that is, the attainment of hotter iron. This can be done either through the elimination of the cupola with the substitution of a better superheating furnace, or through retaining the cupola and supplementing it with a more capable superheating furnace. In view of the unequaled economy of the cupola for preheating and melting, a method of supplementing is preferable. This means the introduction of a duplex process into the gray-iron foundry.

A paper presented at a recent meeting of the American Electrochemical society, held in New York City. The author, George K. Elliott, is chief chemist of the Lunkenheimer Co., Cincinnati.

Duplex processes are well established and of excellent repute among makers of steel; but, for the production of gray iron, they have been entirely neglected, leaving virgin a promising field for development in the making of molten iron for the highest grade of gray-iron castings. For a supplemental furnace to the cupola, there are several eligible types. Among these are the reverberatory furnace, the regenerative furnace and the electric furnace. The air furnace, the author hardly considers sufficiently suited to the work. The regenerative furnace promises better, especially where a large tonnage is to be handled at one time. Still, in the end, the author believes the arc electric furnace presents the most alluring possibilities for really extraordinary castings.

The foundry with which the author has been connected has made a specialty of high-pressure steam-valve castings with extreme solidity exacted, and the tenor of his experiences there has been such as to prejudice him strongly in favor of the basic-bottom arc electric furnace as the best auxiliary for the cupola in a duplex process for the production of truly high-class gray-iron for castings having rigid requirements.

Basic Lining Refines

At this point we anticipate the question as to why the basic furnace is preferred. If superheating only is desired, it is entirely probable that the acid furnace should be given the preference; but if an important amount of refining is advantageous, the basic furnace should be used. It is true that the acid arc electric furnace exerts a considerable refining influence by virtue of the reducing condition so readily maintained in it. On the other hand, the refining tendency of the basic furnace is so much more pronounced and so readily responsive, that the iron charge is perforce refined at the same time it is being superheated. By the time the charge has reached the pouring temperature it also has reached a highly refined condition; and, among other results, the sulphur has been reduced very materially, provided, of course, the proper basic and reducing slag has been maintained.

Sulphur in cast iron has so long been considered a necessary evil that its presence not only is commonly condoned, but occasionally is credited with certain benefits. No doubt there are a few of these last, for instance, where it aids in producing chill; but, in general, there is good reason to believe that iron is much better for its absence. That it induces unsoundness when in excess is general knowledge in foundries specializing in castings of a solidity that is a matter of severe test; high pressure valves are an example. Sluggishness of metal is a closely allied evil that travels in the train of sulphur and works unfavorably to solid castings. A medium or high sulphur content is inevitable in the product of the cupola furnace, while in the basic electric furnace its practical elimination is almost a matter of course. The basic electric furnace removes most of the sulphur while the metal is being superheated. This reaction makes possible for the electric furnace certain obvious compensating economies in the choice of raw materials used in the cupola phase of the process. Iron coming from the cupola with 0.100 per cent sulphur, after undergoing about 25 minutes heating in the basic electric furnace under the proper reducing slag generally will contain about 0.030 per cent. One heat the author has in mind was reduced from 0.099 per cent sulphur to 0.022, and another from 0.088 to 0.018 per cent. This possibility of so low sulphur in gray-iron castings may possibly open up a new field for metallurgical investigation.

Carbon regulation, total as well as combined and graphitic, is possible to a most useful extent in the electric furnace. By placing steel scrap in the furnace before adding the molten iron from the cupola, total carbon can with accuracy be reduced to any desired extent. By this simple, unfailing means, gray iron of the socalled semisteel quality may be obtained with great uniformity of composition, structure and strength. Uniformness among different heats, homogeneity in the individual heat, close carbon regulation, and unlimited temperature, are a quartet of benefits of the electric furnace that make possible a realization of those exceptional qualities so often claimed for and so rarely reached by those cupola-compounded mixtures that are pleased to go under the name of semisteel. Correctly balancing the combined and uncombined carbons also is a matter of no great intricacy in the electric furnace by the vicarious means of the silicon content. Indeed, the capricious vagaries of the cupola with reference to carbon control, are replaced in the electric furnace by substantial certainties.

Low Oxidation Loss

Another advantage accruing from the electric furnace is the possibility of making furnace additions of manganese and other elements for particular purposes, without having to expect more or less appreciable losses; the manganese losses are *nil*. Other benefits there are, but they are of a well-known order, so that their repetition here would be commonplace. The one big advantage from the standpoint of composition is the absolute control of mixture, making duplication of results more a matter of correct calculation and less the effect of happy accident.

A concrete example of results actually obtained in everyday running practice may be of interest. A rather ordinary mixture of pig iron and foundry scrap was melted as usual in the cupola, transferred to a basic electric furnace and there superheated and refined under a lime slag. The untreated iron was of a composition regularly giving standard "arbitration" test bars that broke under an average transverse load of 2950 pounds with a deflection of 0.10-inch. After treatment in the electric furnace, the iron gave the same kind of bars breaking at slightly over 4400 pounds and a deflection of 0.115-inch. The specific gravity was increased from 7.10 to 7.25. About 25 minutes was the time of the electric furnace treatment, and the current consumption was 104 kilowatt-hours for 2000 pounds of iron.

Specific Recommendations

At the beginning of the paper the author indicated several concrete cases which seemed to justify this proposed dual process, and now before closing he wants to define broadly some classes of iron castings for which it may be feasible. In the first place, there are those castings for which there is exacted unusual tenacity, solidity and other physical properties. Secondly, there are those castings that are difficult to run on account of having thin sections and relatively large sizes. Thirdly, there are those castings of high quality whose extreme foundry cost is but a very small part of the total cost of the finished article. For the moment, leaving the cupola, attention may well be called to possible advantages in using the electric furnace in connection with the "direct metal" from the blast furnace, the electric furnace filling the triple role of mixer, superheater and refiner. Such process would make possible high-class gray-iron castings almost direct from the blast furnace at a cost very little higher than that of ordinary cupola iron.

To conclude, the author wants to emphasize the fact that the cupola and electric furnace duplex process for gray iron is not recommended by him as a commercial practicability for ordinary iron castings under ordinary circumstances, but rather as a convenient and extremely efficacious substitute for the cupola process for extraordinary castings or for extraordinary circumstances.

The Fire Proof Shoe Co., Jackson, Mich., has been organized and will start operations about the middle of September. This company will manufacture patented asbestos molders' shoes, leggings, etc., which they will sell direct to foundries desiring them.

Modern Gray-Iron Foundry in Utah

In Order to Keep the Mills, Mines and Smelters of a Large Copper Company Going During the War This Shop Reached a Monthly Production of 900 Tons

By T. F. JENNINGS

WHEN Kipling wrote the famous lines "east is east and west is west and never the twain shall meet" he did not foresee the tremendous changes that were to take place in a few years. Trade and commerce have leveled barriers that at one time seemed insurmountable. Captains of industry have set up their factories and installed their processes in strange lands. Particularly is this true of the casting industry. There are still differences of speech, clothing, customs and manners among the people of the different nations but the methods of producing castings are rapidly becoming identical everywhere.

Consider the case of the American west. Up to a few years ago, and even yet in the minds of some people the names, Utah, Wyoming and California call up visions of buffalo herds and prairie schooners, Indians and gold hunters, Mormons and Danites, blood and gold and violent deaths, all enveloped in a haze of sage brush and revolver smoke. As a matter of fact such things have not only passed away, but they have passed out of peoples minds in the west; if they are recalled it is in the same way that people in the east recall stories of the Pilgrim Fathers and the Boston Tea Party.

The geographical distinction still remains, but there is no east and west as far as industrial life is concerned. The ubiquitous molders, foundrymen and molding machine manufacturers have found their way into every place where castings are needed. They have built shops, set up their machinery and proceeded to turn out castings in as matter of fact way as any foundry in Boston town where castings have been made almost since the days of Miles Standish. Indeed there are foundries not only in Boston but in other old and long established communities which cannot compare either in size, convenience, equipment or output with the Arthur foundry of the Utah Copper Co., located at Garfield, Utah.

This shop has increased remarkably in size and production during the past 8½ years. In 1910 it was located in a small poorly lighted, and ventilated building 61 x 62 feet, which had been taken over from the Boston Consolidated Co. Outgrowing this small building, a new shop was completed in the early part of 1911 which measured 80 x 120 feet. The demand for castings for the copper smelters and the building of the Bingham & Garfield railroad increased the work to such an extent that the foundry was extended 75 feet in 1912, 30 feet in 1915 and 90 feet in 1917. At the present time the main building of the foundry covers an area of 80 x 315 feet; after allowing space for the chipping room, coreroom and cupolas there remain approximately 16,000 square feet of molding floor.

The foundry building and equipment is modern in every respect making working conditions ideal. As may be noted in Figs. 1 and 3 light and ventilation have been amply provided for.

At the back of the foundry the iron and coke yard is on a level with the charging floor. Concrete bins are arranged on this yard to hold pig iron, coke, scrap and molding sand. The floor of the bins slope gradually from the railroad track to the charging floor which simplifies to a great extent the unloading of the cars. All the material in the yard is handled by a 20-ton electric locomotive crane. It is equipped with a magnet and besides unloading all the material it

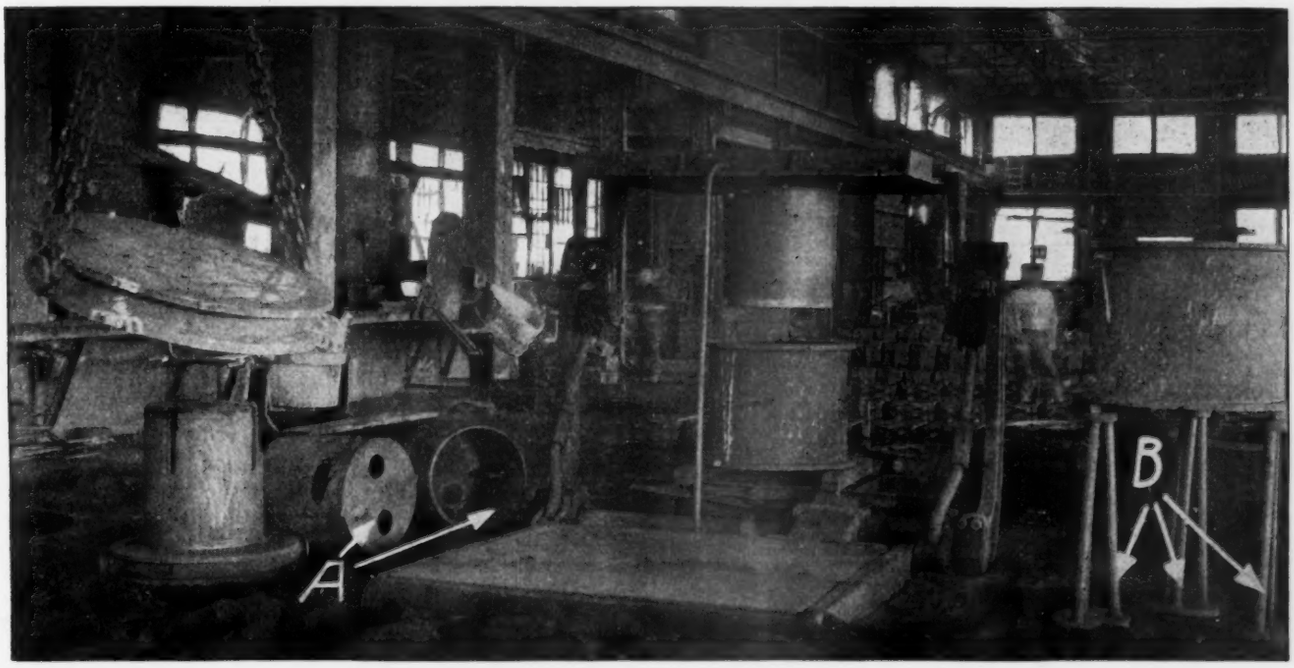


FIG. 1—72 x 72-INCH JAR ROLL-OVER PATTERN DRAWING MACHINE EQUIPPED FOR MAKING CASTINGS SHOWN AT *A*—NOTE THE SPECIAL TYPE OF STAND AT *B* FOR HOLDING THE CHEEK

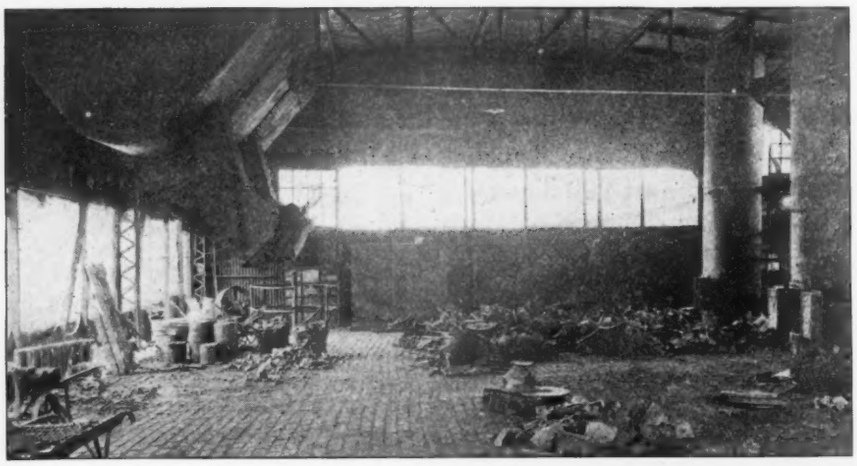


FIG. 2—COKE BUNKER AND CHARGING FLOOR. THE BUNKER IS FILLED WITH COKE THROUGH HATCHWAY IN THE ROOF

handles the drop ball for breaking scrap. Coke is loaded in large boats which the crane dumps into a bunker on the roof of the charging floor. This bunker and the chutes leading down from it are clearly shown in Fig. 2. The crane is also used for removing waste from the chipping room, cupolas, etc.

The brass foundry is located in a separate building from the iron foundry. It is equipped with three oil-fired furnaces having a total capacity of 9000 pounds per day. The brass castings vary in weight from a few ounces to 800 pounds and in quality from plain yellow brass to the best grades of bronze and aluminum alloys.

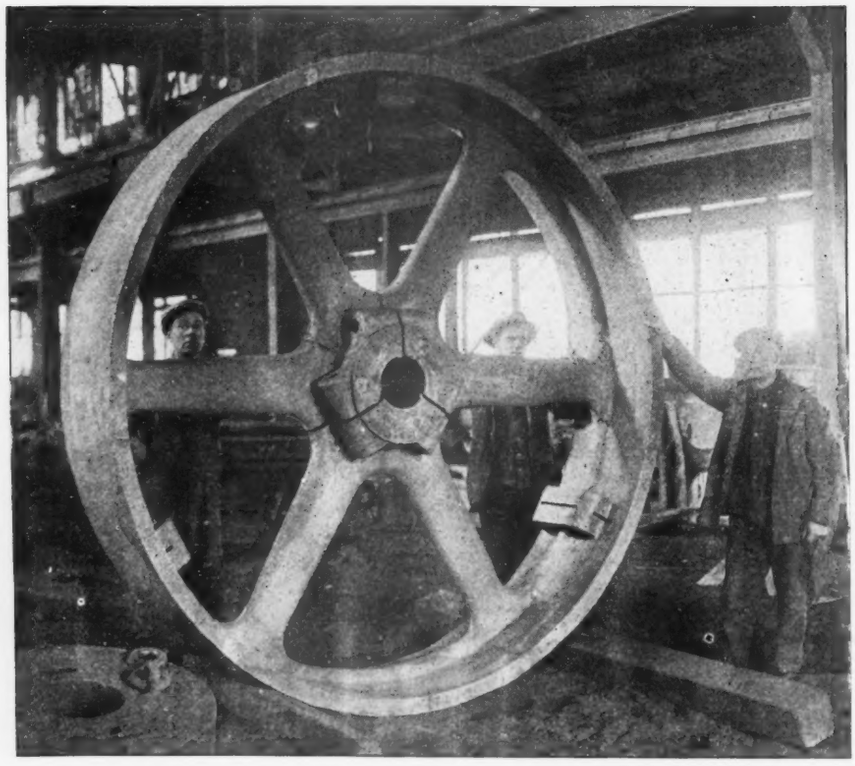


FIG. 3—A 10-FOOT SPLIT PULLEY CAST IN GREEN SAND WITH DRY SAND ARMS AND HUB—T. F. JENNINGS, FOUNDRY SUPERINTENDENT AT EXTREME RIGHT

The main bay of the iron foundry is served by two 15-ton electric traveling cranes running the full length of the building. There is a 3-ton electric traveling crane in the side bay and two jib column cranes of 2000 and 3000 pounds capacity, respectively, in the coreroom. There are three core ovens provided for drying the cores, one car oven and two large five-drawer, modern, oil-fired ovens.

The melting equipment in the gray-iron foundry consists of three Whiting cupolas, Nos. 3, 5 and 7. Their combined melting capacity is in excess of 150,000 pounds per heat. The

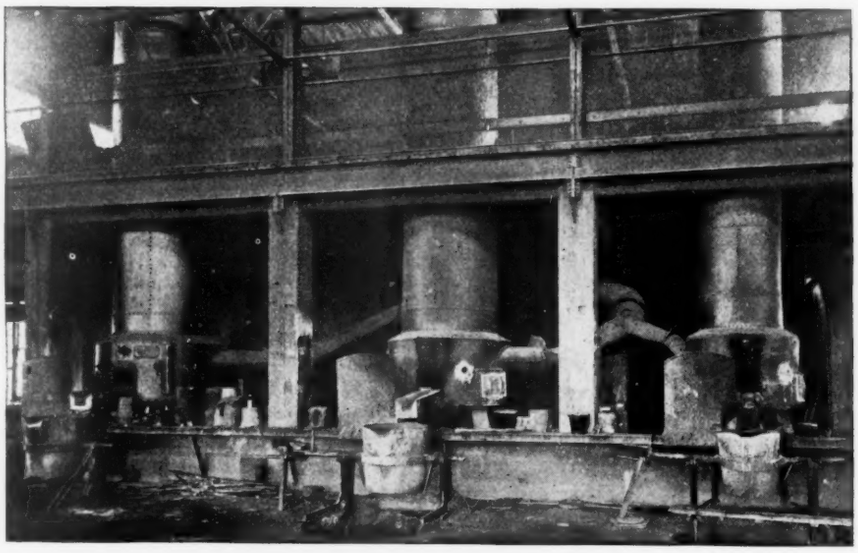


FIG. 4—A BATTERY OF THREE CUPOLAS—NOTE THE CONCRETE WALL ACROSS THE FRONT OF ALL THREE

blast is furnished by three Western Electric centrifugal air compressors and the blast pressure is registered with two Clark blast meters.

The blower room, which is built of concrete, measures 44 x 15 feet. There is a 47-foot wall 4 feet high in front of the cupolas which prevents the drop from spreading around the shop floor. The cinders and shop waste are loaded into large boxes and moved through the end of the shop. When the boxes reach the outside they are loaded on a car by a Link-Belt electric hoist and carried to the dump.

The charging room is built of steel and concrete. The floor has a concrete base with square wooden blocks set on end and wedged with asphaltum. The roof is 20 feet above the floor, and the back wall, which is open for one-half the height, extends the complete length of the charging floor. The general features of the charging floor are clearly shown in Fig. 2.

The molds are made by hand and

also on molding machines of the latest type. One Herman jar-ram roll-over pattern drawing machine, 72 x 72 inches, with pattern, mold and some of the castings produced on it is shown in Fig. 1. There are six other molding machines of various types and sizes used in different parts of the shop. The production of castings has increased from a few thousand pounds per month in 1910 to 1,800,000 pounds in October, 1917.

When the castings are cleaned they are taken from the chipping room on cars which pass over scales where the weight is noted. They are then delivered to the plant machine shop or to the casting stockyard and loading dock from which shipments are made to the various plants of the company. Castings are made of five different grades of metal. Tube mill liners are made of manganese steel.

The working force varies with conditions. It touched the highest point in October, 1917, when a total of 240 men were employed in and around the foundry.

The company operates its own pattern shop. It is 30 x 60 feet with continuous windows around the sides and front. It is provided with eight work benches, six layout boards, two jointers, one band saw, two lathes; one sander, two glue heaters and three trimmers.

In 1916 a new pattern storage was built, 124 feet in length, 64 feet in width and 41 feet high. It is three stories in height and fully equipped with pattern racks throughout. At the present time over 10,000 patterns are stored in this building.

The company's desire for the safety and welfare of the foundry employes is never lost sight of and its accident rating is remarkably low. There has not been a serious accident of any kind, either to workmen or equipment in the past three years.

Local Committees for Foundry Convention at Philadelphia

The convention and exhibition of the American Foundrymen's association at Philadelphia will easily exceed in size and importance any previous affair in the history of the association. A glance at exhibition figures of previous meetings shows that in 1916 at Cleveland 38,000 square feet of space were occupied by the exhibits, 1917 at Boston, 44,000 square feet, and in 1918 at Milwaukee, 42,000 square feet. As early as Aug. 10, 1919, the huge total of 60,000 square feet had already been reserved by exhibitors for this year's big foundry equipment show at Philadelphia. Special entertainment features also are now being arranged by the local committees with the aim of making the social features of the convention unusually attractive. Thomas Devlin, the veteran president of the Philadelphia Foundrymen's association, is chairman, *ex officio* of all committees, and Howard Evans of the J. W. Paxson Co., Philadelphia, is general secretary.

The members of the various local committees are as follows:

Clearing House Committee

Howard M. Bougher, Chairman, J. W. Paxson Co.
Charles W. Asbury, Enterprise Mfg. Co.
H. J. Bannister, George Oldham & Son.
G. H. Clamer, Ajax Metal Co.
Stanley G. Flagg III, Stanley G. Flagg & Co.
D. P. Hopkins, U. S. Cast Iron Pipe & Foundry Co.
W. J. Johnson, Baldwin Locomotive Works.
George C. Matlack, William Cramp & Sons Ship & Engine Bldg. Co.
Staunton B. Peck, Link Belt Co.
Charles Suess, Westinghouse Elec. & Mfg. Co.
Walter Wood, R. D. Wood & Co.
Thomas Kaveny, Herman Pneumatic Machine Co.
Frank Hodson, Elec. Furnace Construction Co.
Silas M. Tomlinson, Frank Samuel.
The chairman of each of the following committees is also a member of this committee.

Information Committee

George F. Pettinos, chairman.
Cyrus Borgner, Cyrus Borgner Co.
W. T. Dunning, Chester Steel Casting Co.
H. A. Ross, Ross-Tacony Crucible Steel Co.
Joseph E. Stutz, Thomas Devlin Mfg. Co.
R. C. Thum, Aetna Foundry Co.
W. G. Summers, Phoenix Iron Co.
W. J. Coane, Ajax Metal Co.
J. C. Childs, Austin Co.
J. H. Schwacke, William Sellers & Co.
T. C. Voorhees, Hickman, Williams & Co.

Reception and Hotel Committee

Hon. W. C. Sproul, governor state of Pennsylvania, honorary chairman.
Hon. Charles M. Schwab, vice chairman, Bethlehem Steel Co.
H. W. Brown, acting chairman, Tabor Mfg. Co.
G. H. Clamer, Ajax Metal Co.
George C. Davis, Chemist.
E. S. Dailey, William Adams Foundry Co.
Edwin Elliot, Midvale Steel & Ordnance Co.
J. S. Hibbs, J. W. Paxson Co.
W. S. Quigley, Quigley Furnace Specialty Co.
W. H. Ridgway, C. Ridgway & Sons Co.
W. J. Shennan, Foundry Dept. Bethlehem Steel Co.
E. M. Taggert, J. W. Paxson Co.
C. H. Wollaston, Lobdell Car Wheel Co.

Visitation of Plants

George C. Davies, chairman, Pilling & Crane Co.
S. J. Creswell, S. J. Creswell Iron Works Co.
H. E. Mandeil, W. W. Lindsay & Co.
S. W. Mitchell, Philadelphia Roll & Machine Co.
Walter T. MacDonald, Fletcher Works, Inc.
C. H. Newcomb, Crocker Brothers.
F. J. Ryan, American Metallurgical Co.
George Somerhalder, Westinghouse Elec. & Mfg. Co.
H. B. Taylor, George F. Pettinos.
S. R. Vanderbeck, Whiting Foundry Equipment Co.
E. J. Decker, Paul S. Reeves & Son.
Thomas Holt, Camden Foundry Co.
George Fox, Philadelphia Sash Weight Works.
F. E. Schwarze, Cleveland Pneumatic Tool Co.
A. G. Hauck, Philadelphia Fire Brick Co.
A. F. Kempe, W. J. Rainey, Coal and Coke.

Publicity Committee

C. R. Spare, chairman, American Manganese Bronze Co.
H. A. Bomberger, Verilite Metals Co.
T. Harold Brown, E. E. Brown & Co.
J. W. Graham, Kitson Co.
Charles E. Pettinos, 802 Abbott building.
A. G. Warren, J. W. Paxson Co.
E. Arthur Bernstein, Bernstein Mfg. Co.
Charles E. McEvoy, H. A. May Foundry Co.
George M. Benkert, Fairmount Foundry Co.
H. W. Gledhill, Shepard Elec. Crane & Hoist Co.
H. L. Heuszey, Carborundum Co.
H. J. Winters, T. P. Kelley & Co.
H. L. Haldeman, Pulaski Iron Works.
W. E. Wallace, Matlack Coal & Iron Corp.
M. R. Taggart, J. W. Paxson Co.

Finance Committee

C. P. Pond, chairman, David Lupton Sons Co.
C. T. Bird, Pancoast Corp.
Thomas M. Eynon, Eynon-Evans Co.
J. H. Golding, Autocar Co.
W. W. Hearne, Matthew-Addy Co.
W. S. Hollowell, Harrison Safety Boiler Works.
Charles E. Muend, Haines, Jones & Cadbury Co.
J. Harry Mull, William Cramp & Sons Ship & Engine Bldg. Co.
J. T. King, Harbison & Walker Refract. Corp.
E. H. Redmond, Fairmount Foundry Co.
James S. Stirling, Hilles Jones Co.
George R. Sullivan, Rogers, Brown & Co.
Josiah Thompson, J. Thompson & Co.
C. K. West, General Electric Co.
W. J. Davis, McHatton Foundry Co.
S. E. Hadley, W. W. Sly Mfg. Co.

Entertainment Committee

Frank Krug, chairman, White & Brother.
R. R. Belleville, Dixon Crucible Co.
C. D. Matthews, Camden Iron Works.
A. J. Myer, Abram Cox Stove Co.
F. J. Ryan, American Metallurgical Corp.
J. H. Sheeler, Sheeler-Hemsher Co.
C. M. Trivett, P. Isham.
Frank Overn, Federal Steel Foundry Co.
S. J. Beck, Supt. Foundry, Pusey & Jones Co.

Golf Committee

Otto W. Schaum, chairman, Fletcher Works.
Howard Evans, J. W. Paxson Co.
J. R. Neilson, Ajax Metal Co.
L. U. Park, Park & Williams.
C. B. White, White & Bro.
H. F. Rebmann, American Engineering Co.

Loan of Automobiles

Herbert J. Bougher, chairman

C. M. Benkert	H. W. Brown
C. F. P. Buckwalter	C. P. Pond
Wilfred Lewis	C. B. White
Charles E. McEvoy	J. W. Paxson Co.
Wesley Caskey	J. D. Johnson Jr.
Capt. J. L. Crawford	J. H. Sheeler
W. F. Sauter	H. M. Bougher
H. A. White	H. F. Rebmann
Howard Evans	Thomas Devlin
C. M. Trivett	R. C. Thum
G. H. Clamer	Frank Hodson
Otto W. Schaum	F. B. Patt
F. L. Webb	W. H. Ridgway
George F. Pettinos	J. H. Golding
M. L. Kirn	A. G. Warren

Gas Holes in Malleable

By H. E. Diller

Question.—We find small holes, about pea size, in our malleable castings from two patterns. Both castings have the inside cored out with a dry sand core. The cores have a ⅛-inch vent which is taken through the cope from the top of a coneshaped print above the core print. Please advise us what we can do to prevent the blow holes.

Answer.—From your description we would judge the trouble is that your cores gather moisture, or that your iron is too low in carbon.

To avoid the first difficulty it would be necessary to be sure the cores are used reasonably soon after they are baked and not allowed to stand in the mold any considerable length of time. Should this not be practical a rosin core could be made which would not take up moisture.

If the trouble is with low carbon in your iron, this will have to be overcome by melting in a less oxidizing atmosphere, which means the use of less air. The carbon is low enough when it is down to 2.50 per cent and care should be taken to see that it does not run much below this in any part of the heat. The writer has seen heats that have been so highly oxidized that, the last iron contained 0.50 per cent less carbon than the first iron.

Institution of British Foundrymen

Report of First Meeting of the Old British Foundrymen's Association Under Its New Name—Papers on Sands, Molds and Patterns Presented—The President's Address Deals With Labor Problems in England

By JOSEPH HORTON

FOR many years the leading organization of foundrymen in the United Kingdom has been known as the British Foundrymen's association. At the sixteenth annual meeting held in Liverpool, July 17 and 18, it was announced that the society hereafter will be called the Institution of British Foundrymen. It also has been decided to apply for a charter of incorporation. About 80 members from all parts of the kingdom were present at the Liverpool convention.

John Little, Manchester, president of the association, occupied the chair during the meeting. Among those present were T. H. Firth, the retiring president; M. Riddell, vice president, and the following past presidents: R. Buchanan, F. J. Cook, W. Mayer and J. Ellis, together with a number of members of the general council. The meeting took place in the Royal Institution, Colquitt street.

The annual report of the council showed a total membership of 1544, compared with 1058 at the time of the previous annual meeting. This is much the largest increase in the history of the association. The establishment of a new branch at Coventry, now having a total membership of 226, is largely responsible for this increase, but all the nine branches show gratifying growth, Birmingham coming second in this respect with an advance from 138 to 189 members. J. E. Hurst, Manchester, was appointed to represent the institute on the British Engineering Standards association's committee on cast iron and will report to the general council. Prof. H. C. H. Carpenter, London; Prof. A. Campion, Glasgow, and Professor Rhead, Manchester, were elected honorary members of the association in recognition of their valuable services to the foundry industry and to the association.

In his address, which was delivered at the opening session, the president, John Little, dwelt largely on the labor question which at present is so vital not only in England but in every country in the world. Attention was called to the temptation for the nation to rest. Mr. Litle said in part:

Rest at this juncture would be fatal to our best interests. It is precisely what the enemy would most like to see. Hostilities in the field are over, thank God, but the fabric, the shattered fabric of our industrial system must be rebuilt, not entirely on the old lines, but rather in accordance with the special requirements of the new era, the dawn of which we have been permitted to witness. Presently we may be able to take things easier. That moment, however, is not yet. Today and tomorrow we must continue the struggle, and upon our ability and determination to do so depends the real victory of the past five years' struggle. We are passing through a phase of industrialism absolutely without parallel. We are in the midst of a revolution, before the mysterious forces of which old ideas cannot stand, and in the economy of which many time-honored methods and institutions are finding no place.

One of the most important problems of reconstruction is that of labor. What can be done to increase the supply of skilled men, and to insure that within a generation the ranks of working foundrymen shall be brought up to the fullest possible strength, every man bearing the hall-mark of proficiency? Compared with other sections of the iron and steel industries, molders' wages stand very well indeed. In spite of that, however, there has been for many years, even in prewar days, a danger of lowering the standard of efficiency. What is responsible for this serious state of affairs? In my opinion, and I have been in a position to observe, the trouble begins at the very base. It begins with the system of apprenticeship, or rather, the lack of it.

How many youths and men are there in the foundries today who are scarcely able to write their names legibly, or read a drawing? It is a deplorable state of affairs and cries loudly for rectification. The remedy, I believe, is not far to seek. Let the old system of binding a lad as an apprentice be restored. If possible let him remain at day school until the age of 16 years, but, in any case, as soon as he has become apprenticed arrangements should be made for him to continue his schooling by attending classes a certain portion of each day on his employer's time, with no deduction from his wages. You cannot reasonably expect a lad to leave his day's work in the foundry and of his own free will, passing by his companions on pleasure bent for the evening, commence studies at night classes. Some will do it, and even eagerly in their determination to progress; but they are in a minority, and it is the majority we have to deal with in such a question as this.

Let me once more emphasize the gravity of the question of output. We must preach it in season and out of season. The hope of our industrial future is bound up with it. The output per man must be greatly increased, or we are nationally lost. No reasonable employer disagrees with a man's wage-earning power being increased, nor with the shortening of the hours of labor, but failure to at least maintain the output of this country's shops will play right into the hands of foreign competitors and lead to the ruin of the bright prospects now open to us as a result of the great victory of the allies. It is no use for us to turn our faces from the truth. Labor today is being made the victim of influences which are inimical to the general happiness and prosperity of the nation. We appeal to the uprightness and common sense of the genuine British worker and urge him to awaken to a sense of the actual position of things, to discern between the truth and deception, before it is too late to do either the one or the other.

We have just seen the treaty of peace signed, and now commences a great international fight for trade under reconstructed industrial and commercial conditions. It will require every ounce of energy and sound common sense to pull off a victory, but as certain as night follows day there will be no middle course.

We are in this new campaign for a plain issue, industrial and commercial life or death, and the man, or section of men, neglecting the least opportunity of assisting the country to win is a traitor.

Several papers were read during he conference and each one was thoroughly discussed by a number of members who gave their individual experiences and viewpoints. Prof. P. G. H. Boswell, Liverpool university, Liverpool, read a paper in which he compares the molding sands of Great Britain and America. Professor Boswell's remarks in regard to molding sands in United States were based largely on his study of American foundries while visiting this country in the fall of 1918 at the request of the British ministry of munitions. This paper brought out a general discussion in which W. Mayer, F. J. Cook, T. H. Firth and President John Little took part. It is published on another page of this issue of THE FOUNDRY.

In reply to questions, Professor Boswell said that he had intended to give a good deal of information as to physical tests, but he had been unable to complete a number of analyses which he commenced last February. He had always held, he said, that chemical analyses of themselves are of little use and foundrymen complain very justly

that such analyses give them no practical information. With regard to sand mills, those used in America are large, with rollers in some cases weighing up to 500 pounds. Dr. Boswell, however, said he is opposed to large mills, and he supported those in the meeting who advocated the general use of small mills. In Belgium, relatively small mills are used with light rollers. It is quite a common practice to have one of the mills fluted, so as to assist in breaking up the sand as completely as possible. Dr. Boswell thinks a small mill, say 2 feet 6 inches by 3 inches, is satisfactory. Although he saw very large mills in the states he never found any reason to favor any of that class of machinery.

In discussing J. E. Hurst's paper on permanent molds and centrifugal castings, S. J. Smith said that in the preparation of the dies, he aims to get a high combined carbon and has found considerable difficulty in getting the metal sufficiently hard. But he has also found that it is possible to get the combined carbon a little too hard for machinability. He said he was very glad to hear from Mr. Hurst that it is possible to produce as many as 2500 castings from a single die, but his own experience is that an average of from 1000 to 1500 nonferrous castings are obtained from a die. He does not think there is a better metal for dies than cast iron. In die casting there is more difficulty in getting away the air from a die than from a sand mold, and special provision must be made for its exit. If a die is found very troublesome in this respect, the best thing to do is to scrap it and make another.

Life of the Mold

F. J. Cook said one of the difficulties arising with regard to the maintenance of output of such articles as small pistons relates entirely to the life of the mold. About 500 castings represent the capacity of an ordinary permanent mold, probably due to the rapid casting. If a longer time were allowed for casting it might obviate the difficulty, but if only 15 seconds is allowed the mold would become overheated. One of the outstanding features is the size of the grain of the metal of the mold and that is of more importance than the amount of the combined carbon. The silicon content is also very important, because of the breaking up of the pearlite structure. With 1.25 per cent instead of 1.50 per cent silicon, as mentioned by Mr. Hurst, the life of the die is materially improved.

The final paper of the meeting was by H. Sherburn Warrington, on the production of pattern plates for repetition castings. The afternoons were spent in visiting places of interest near Liverpool. On Thursday afternoon, July 17, the works and shipbuilding yards of Messrs. Cammell, Laird & Co., Birkenhead, were inspected at the invitation of the managing director, Sir George Carter. In the evening a dinner was held for the members at the Exchange Station hotel. On Friday afternoon the village and works of Lever Bros., Ltd., Port Sunlight, were visited. There was also an excursion to Southport and some of the members visited one of the Atlantic liners in dock.

Pattern Manufacturers Hold Convention

The second annual convention of the National Association of Pattern Manufacturers was held at the Statler hotel, Buffalo, Aug. 16 and 17. The roll call disclosed the fact that there were representatives present from 26 different branches.

President E. F. Ball delivered the opening address. He said the year just past had been an eventful one and might be referred to as a period of waiting. Before the signing of the armistice, business had been in a more or less chaotic state; and since the armistice had been signed conditions in the pattern making and other fields had not improved to any appreciable extent. He touched on recent labor troubles from the standpoint of the association and made several suggestions and recommendations for their elimination in the future.

A resolution to the effect that the interests of the association would be advanced through the members cultivating a spirit of trust, fairness and co-operation or, in other words, an observance of the golden rule in all their dealings with each other, was adopted unanimously.

At the Saturday afternoon session the convention committee submitted its report. After some discussion it was decided to hold the 1920 convention in Toledo, O., on the second Friday in August and the day following. Several other questions of interest to the association were taken up and disposed of.

The resignation of A. H. Poole as a trustee was accepted and regret expressed that he had found it necessary to sever his official connection with the board.

All the retiring officers were re-elected unanimously. The personnel for the ensuing year will be: President, E. F. Ball, Newark Stamping & Foundry Co., Newark, O.; first vice president, Vaughn Reid, City Pattern Works, Detroit; second vice president, J. W. Brost; secretary-treasurer and business manager, E. O. Melville, Melville Bros., Columbus, O.

Trustees were elected for one, two and three years as follows: S. H. Thompson, S. H. Thompson Mfg. Co., Dayton, O., for one year; J. H. Bridge, Maumee Pattern Co., Toledo, O., two years, and A. E. Schuchert, A. E. Schuchert Pattern Works, Cincinnati, three years.

The Buffalo branch provided entertainment for the visitors. On Saturday afternoon the ladies were taken for an automobile ride around the city and environs. At 7 p. m. a banquet was held in the banquet hall of the Statler hotel, at which an address was presented by D. D. Fennell, general manager, Belmont Rubber & Packing Co., Buffalo. The speaker made a strong plea for closer personal relations between employer and employe. On Sunday the party boarded special trolley cars for a sightseeing tour of Niagara Falls.

New England Foundrymen Visit Providence

Nearly 200 members of the New England Foundrymen's association held their annual summer outing on Aug. 13 and were treated to a shore dinner at the Pomham club, Providence, R. I. The association holds outings occasionally for relaxation and for the purpose of having a good time. The entertainment committee provided automobiles to convey visitors from the station to the club, which with its grounds and accessories was turned over for the day to the foundrymen. Late in the afternoon, having concluded an informal program of music, etc., the members departed for the West Side club of Providence where further entertainment and refreshments were provided.

Facts About Blowers

Much valuable information on rotary positive blowers, gas exhausters, pumps and vacuum pumps, couplings, blast gates, relief valves, feed devices and governors is contained in a bulletin issued by the P. H. & F. M. Roots Co., Connersville, Ind. Complete tables giving sizes best fitted for various uses with capacity, speeds and other data useful to the engineer feature this bulletin. The principle utilized in the impellers and blowers made by this company is clearly set forth. Many illustrations assist in making plain the text.

An alloy for making jewelry consists of gold, 74 parts; platinum, 4.5 parts and palladium, 21.5 parts. It is similar to platinum in appearance.

Compares Molding Sand Practice

English Geologist and Molding Sand Expert Sent to America During War by Ministry of Munitions Discusses Molding Sands and Foundry Practice of Britain and America

By PROF. P. G. H. BOSWELL

THE writer visited the United States in the fall of 1918 at the request of the British ministry of munitions to make a study of, and report on, the use of molding sands in that country. The saving which might be effected by the use of ideal sands in metal castings amounts to many millions of dollars each year.

The problems involved in the successful founding of iron and nonferrous metals and alloys, such as copper, aluminum, bronzes, brass, light alloys, etc., are due in a less measure to the molding sand used than in the case of steel. The temperatures reached in casting these metals and alloys rarely exceed 1250 degrees Cent., whereas steel might be, and is, frequently run at temperatures approaching 1700 degrees Cent. The foundry practice studied by the writer in the United States and Canada mainly dealt with steel-production; incidentally, iron and brass foundries were visited, especially where they accompanied steel foundries in the same or related works. The following comparison, therefore, deals mainly with steel-production.

A Competent Critic

PROF. P. G. H. BOSWELL, author of this article, is head of the department of geology, University of Liverpool, England. It is in the molding sand field, however, that he enjoys special distinction, having devoted a large portion of his life to a study of sand problems. In this connection he has engaged in much research work and has personally visited many of the world's deposits of sand and studied their individual characteristics and bonding qualities. During the war the British Ministry of Munitions retained Dr. Boswell's services to investigate molding sand practice in British foundries. Later he was sent to America to study the sands of this country. In this paper, which he delivered before the British Foundrymen's association at its annual meeting in Liverpool in July, Dr. Boswell compares American and British sands and discusses the practices in vogue in the two countries.

Rolling Mills Use Steel

The enormous steel output of the United States is largely produced for rolling mills, and stamping and forging shops. It takes, therefore, chiefly the form of plates, sheets, bars, rails, stampings and forgings. The output of castings is considerably less in volume and the steel foundries, like the iron and brass foundries, are often merely adjuncts to the rolling mills and forging shops. In such cases the foundries produce big quantities of wheel-centers, housings, rolls, and other machine parts to replace those which become worn or broken. A large proportion of the work carried out in the remainder of the steel foundries consists of locomotive castings, the upkeep and rapid growth of the extensive transportation systems of America having necessitated the development of numerous big foundries. In many cases the output of the foundry is employed entirely for the works' own use.

Small jobbing shops which turn out castings of a miscellaneous character and often of variable size, appear to be considerably less abundant in America than in Britain. An attempt has been made to standardize and combine a number of these smaller works. It is perhaps early yet to judge of the success of the venture.

It is common knowledge that considerably more basic than acid steel is produced in America and the tendency towards the further reduction of the acid output is very marked. Castings are produced from both basic and acid steel, but the output of acid steel castings shows a tonnage about one-third greater than that of basic steel castings. About three-quarters of the tonnage of the steel used for castings is produced in open-hearth furnaces.

Green-sand molding is much less common in America than in Britain, and is reserved for small work. It is more frequently practiced in the Middle West than in the Eastern states. The unwillingness to make green-sand castings might be attributed to the sands used, which are perhaps more suitable for dry-sand work. It would, however, be difficult to sustain this objection, and, in short, it is the opinion of the writer that American green-sand molding falls, in the matter of foundry technique, behind the British practice.

Types of Molding Sands

The sands used for the casting of iron, brass, etc., require and receive only incidental attention. Erith (or Thames) sand was actually imported, though quite needlessly, into America before the war. The famous sand from Albany, N. Y., is strikingly similar to Erith sand in analysis, texture and behavior, and like the latter, is used in the casting of iron, bronze and brass. For heavy iron castings, local sands of fairly coarse grade are utilized. One of the most popular in the Eastern states is that from near Millville, N. J., known as "New Jersey gravel." Others, also from the same state, used for the casting of brass, are known as Lumberton and Howall sands respectively. Cores are prepared for brasswork from a fine silica sand such as that worked for glass-making in Pennsylvania, bonded with oil. None of the above mentioned sands are sufficiently refractory for steel-casting, and most of them are also unsuitable in grade.

No sands are found in the United States similar to our widespread and valuable deposits of Bunter age (Birmingham, Kidderminster, Mansfield, Wolverhampton, Stourport, etc.), which are the backbone of our foundry sand industry, so far as iron, brass, etc., are concerned. These sands have a markedly rich red color, resulting from the ferruginous bond, and also possess characteristic chemical and mechanical constitution.

Molding-sands used for the casting of steel may be divided roughly into two classes:

(*a*) Those in which the natural clay bond is sufficiently strong in itself for foundry purposes;

(*b*) Those requiring the addition of fireclay and some artificial bond, such as molasses, flour, dextrin, oil, etc., to yield a strong structure.

Throughout the British area, the

sands used are almost without exception those falling into the first class. On the other hand, the practice most widely adopted in America is to use artificially bonded silicia sands. Only in the Eastern states, where supplies of naturally-bonded steel-molding sands are found in New Jersey, is the practice similar to our own. Even in New Jersey no sands have been found which carry a bond so strong or so highly ferruginous as that of our high-class western European molding-sands such as Belgian red, Belgian yellow, French red, French yellow, etc.

Excluding certain scattered and relatively less important foundries, we may group steel-founding in the United States into three chief areas:

(*a*) The Middle West, the chief centers of which are Milwaukee, Chicago and St. Louis. High-silica sands, artificially bonded, are used exclusively in this region.

(*b*) The Ohio-Pittsburgh area, where sands from Ohio and Pennsylvania are mainly used. The sands are high-silica sands, but are not so pure as those used further west. They carry a slight natural bond, but not sufficient to bring the silica content below 95 per cent. Artificial bonds are necessary to give them the required consistency and strength.

(*c*) The Eastern seaboard, including particularly the areas around Philadelphia, New York, and Boston. In the matter of the sands used, Montreal and Nova Scotia may be considered to lie in this belt. The molding sand employed is almost exclusively New Jersey sand, which has a moderately strong natural bond. The silica percentage is much higher, however, and the alumina percentage lower than those of British used materials (SiO_2, 80 to 89 per cent; Al_2O_3, 4 to 9 per cent). The sands are less ferruginous, the smaller percentages of ferric oxide and alumina accounting for the weaker bond. Occasionally the New Jersey sands are used in the American foundries without the addition of an artificial bond, but in most cases molasses, flour, dextrin or other compounds are added to the sand.

New Jersey sands are also transported to the Pittsburgh area mentioned under (*b*) above, but their use is not extensive in that area on account of the high expense of transporting them.

The outstanding difference in practice on the two sides of the Atlantic, therefore, hinges upon the use of artificially bonded high silica sands. Among the sands most extensively employed for this purpose are the well known deposits worked for glassmaking, abrasive and other purposes by many companies near Ottawa, Ill. To a much smaller extent, other sands, such as those from Pacific, Mo., northern Pennsylvania, etc., are used.

The Ottawa sand is white or pale-

Comparison of Naturally and Artificially Bonded Sands

1.—A better finish is obtained upon the castings, especially if the bond is ferruginous, when a sound, smooth, blue skin is obtained. The casting strips freely even when hot.

2.—In the present practice fewer troubles, like scabs, blowholes, and burning-on are experienced.

3.—The bond is stronger when wet.

4.—The sand is not easily standardized and made fool proof. It is liable to considerable variation in the field, and consignments often differ in composition.

A skilled workman is required at the mill to mix the sands properly, to keep the composition constant, and to mill the product for the correct period of time.

5.—More delicacy is possible in the variation of the composition of mixtures according to the classes of work in the foundry (e.g., as many as seven types of molding mixtures may be made.)

6.—On the other hand, too many constituents for simple work are often present in the mixtures. The number is frequently four and sometimes reaches five.

7.—In the chemical analyses of material of different grades present, the sand-grade or high-silica portion is not so refractory as a natural high quality silica sand. The clay grade also is less refractory than the highest quality fireclays.

8.—The fine sand, superfine sand and silt are not absent, although in the best sands the proportion is low.

9.—The best molding sands carry considerable quantities of colloidal hydrated iron oxide. This compound improves the bond and life of the sand and assists the stripping and soundness of the casting. (See 1, above.)

10.—Reclaiming of sand is not easy owing to the considerable quantity of burnt clay present. Less old floor sand can be used in the mixture.

11.—The available quantities of naturally bonded sands in Britain are (excepting the less well bonded Scottish rotten-rocks) strictly limited. The reserves of foreign sands are also inadequate; in any case, we ought to be independent of them. The best known naturally bonded sand is from Belgium.

Artificially Bonded Sands

1.—The finish is rougher, the surface of the casting having a gray color and frequently being pitted.

2.—At present, trouble is caused over scabbing and blowholes.

3.—The bond is weaker until the mold is dried. working is therefore not so easy, and molds left standing are more easily damaged.

4.—The molding sand is easily standardized and the method practically fool proof. High silica sands almost always run true to sample, as do also the fireclays used In any case, the quantity of the latter is small.

Unskilled labor can be employed at the mill, and the mixture milled for a given time.

5.—Less adaptability is shown to different kinds of work.

6.—The molding mixture is generally composed of two materials, together with an artificial bond. Rarely, three are used.

7.—Both high silica sand and fireclay may be chosen for their chemical composition and exceptional refractoriness to heat.

8.—The venting is improved if the separate sand and clay are so selected that silt and fine sand are absent.

9.—Colloidal hydrated ferric oxide is practically absent. The bond is therefore weaker and the skin of the casting less good. Stripping is more difficult.

10.—The artificial bond burns out, and the amount of fireclay which is calcined is small. A little fireclay is thus sufficient to restore the sand. As much as 80 per cent of floor sand can be used in a new mixture.

11.—The available quantities of high silica sands and fireclays are practically unlimited, both in the United States and Britain. Independence of foreign supplies is assured. British resources are as high in quality as those from abroad.

colored, a chemical analysis of an average sample being as follows:

	Per cent
SiO_2	98.47
Al_2O_3	0.75
Fe_2O_3	0.08
MgO	0.08
CaO	0.21
K_2O	0.06
Na_2O	none
TiO_2	0.05
Loss on ignition	0.47
Total	100.17

The chemical composition of the slime washed from the sand is as follows:

	Per cent
SiO_2	87.21
Al_2O_3	7.50
Fe_2O_3	0.52
MgO	none
CaO	none
Na_2O and K_2O	0.20
	95.43

Remainder mainly water.

The chemical analysis shows the sand to be highly refractory to heat, for the silica content is very high and the proportion of alkalies and alkaline earths very low.

The importance of the grade of a molding-sand cannot be over estimated (see "British Resources of Refractory Sands.") The Ottawa sand is well graded and consists mainly of the medium sand grade.

Siliceous Fireclay Employed

The relatively large quantity of material in the coarser grades and the small amount of silt and clay, insure open and well vented sands.

Other silica sands employed in the same way occur at Massillon, O., Phalanx, O., Utica, N. Y., Franklin, Pa., and Millville, N. J. Several of these carry also a small quantity of clay and ferruginous bonding material, which at times reduces their silica percentage to 95 or 96 per cent. Chemical analyses of the Portage and Massillon sands in terms of percentages are:

	Portage Per cent	Massilon Per cent
SiO_2	98.30	96.27
Al_2O_3	0.59	1.70
Fe_2O_3	0.53	0.55
MgO	0.10	0.11
CaO	0.16	0.16
Na_2O	0.04	0.07
K_2O	0.18	0.38
TiO_2	trace	0.12
Loss on ignition	0.42	0.83
Totals	100.32	100.19

Besides the artificial bond, which in most cases is molasses, and less frequently flour, sulphite-lees, or dextrin, a siliceous fireclay is usually added to the silica sands mentioned above. Only a small quantity of this binding clay is necessary, the proportion generally varying from 3 to 7 per cent. The addition of fireclay necessarily lowers the refractoriness of the sand, whereas the presence of the molasses, dextrin, etc., makes no difference. As small a quantity of clay as possible is, therefore, used, and in order that the binding quality may be a maximum, the clay selected is as plastic as possible, consistently with being highly refractory.

One of the most popular bonding clays in use in the Pittsburgh district and on the Eastern seaboard is that from Welsh mountain, Pennsylvania. It is a cream colored or yellowish fireclay, having the following chemical composition:

	Per cent
SiO_2	62.50
Al_2O_3	21.46
Fe_2O_3	1.74
FeO	1.29
MgO	1.13
CaO	0.14
Na_2O	0.19
K_2O	4.28
H_2O+	5.81
H_2O-	0.61
TiO_2	1.04
P_2O_5	trace
CO_2	none
MnO	trace
BaO	trace
Ce	trace
Loss on ignition	....
Total	100.19

Fireclays from Illinois are similarly used in the Chicago-St. Louis area for bonding purposes. Some of the fireclay seen in the works was so siliceous as to resemble our Scottish "rotten rocks."

The clays are ground to pass through 80-mesh screens before being supplied to the steelworks. They are then added to the sand in the desired proportion and ground for a few minutes with the addition of molasses and water, in a pan mill, the procedure being in that respect similar to our own, but the time of milling being less. The molding mixture when taken from the mill is much less tough than our naturally bonded sands, for the full effect of the artificial binder is not seen until the mold dries. In certain cases no artificial binder is added in the mill; the sand and clay are ground together with water, and the face of the mold when made is washed over with molasses or dextrin water. Molasses water is used in preference to flour or dextrin on account of its lower cost.

The American practice in regard to naturally bonded molding sands does not differ very appreciably from ours. The use of such sands is, however, much more limited. The sands from Portage and Massillon, O., bear a slight bond, but it cannot be compared in strength with that of western European sands. Practically speaking the only naturally bonded sands worked in America are those of New Jersey. The binding material in them is clayey, but not strongly ferruginous; it is therefore less strong than that of Belgian, French or British materials. The bonded sand is milled alone or with a high silica sand in a pan mill. In some works an artificial bond is also added, in other cases a fireclay such as Welsh mountain silica clay is mixed with the sand. The resulting product, in any case, does not attain such a tough condition as that of British sands.

The fat sand, from Messrs. Paxson & Co.'s quarries at Millville, N. J., has the following composition:

	Per cent
SiO_2	82.14
Al_2O_3	8.90
Fe_2O_3	2.15
FeO	0.14
MgO	0.31
CaO	0.19
Na_2O	0.10
K_2O	1.22
TiO_2	0.86
H_2O+	3.02
H_2O-	1.16
Total	100.19

In many respects the Scottish practice of using "rotten rocks," the bond of which is often assisted by the addition of treacle, flour, etc., may be considered as intermediate between the English practice of using natural strongly bonded sands, and the American practice of using high silica sands cemented by fireclay and an organic binder. The Scottish rotten-rocks are soft sandstones largely composed of quartz, but carrying also a certain proportion of micaceous and china-clay products, which have resulted from the decomposition of feldspar grains once present in the rock. The clayey material provides a certain amount of bond, but as it is insufficiently strong, the rock is milled with a small quantity of fireclay and sometimes an organic binding material. In most cases the latter is diluted treacle. It is noteworthy that, as in America, steel-castings made in these sands possess a gray skin and do not strip so freely or readily as those made with facing sands carrying a ferruginous bond.

Core Making Practice

Coal or sawdust is occasionally used, in the same manner as at home, for opening up and venting a steel molding sand. The use of either material is not widespread, venting being generally obtained by the admixture of coarser high silica sand.

The practice in coremaking varies in the United States as it does in Britain. In some cases a high silica sand bonded with oil is used, in others the bond is rosin. Silica flour was often added to the core mixture, and a sand for use between the teeth of wheels consists similarly of a mixture of high silica sand and silica flour. The "flour" was prepared by grinding either a pure silica sand, *e.g.*, Ottawa, or a pure quartzite, *e.g.*, Wisconsin.

Silica flour in varying quantities up

to 1 or 2 per cent is sometimes also added to the ordinary molding sand in the pan mill. The casting probably skins more freely from the molding sand as a result of this procedure, and the refractoriness of the sand is obviously increased. The facing sand of cores is occasionally prepared with a much larger quantity of silica flour in the core sand, with the object of reducing "burning-on" as far as possible. It should be remembered that the silica flour is ground to a fineness which yields a certain amount of plasticity and bonding power. The admixture of china clay (kaolin) with molding sands was nowhere observed.

The quantity of old floor sand used in molding sand mixtures varies from nothing to 80 per cent. The latter quantity is higher than in the British practice, where 50 per cent may be taken as a maximum. The use of a greater quantity of old sand reduces costs appreciably, but it is probably related to the character of the sand. The artificial bond burns out, the burnt clay rubs away in part, and a small quantity only of fireclay is sufficient to "revive" it.

Use of Composition

The "compo" or composition of the British steel-founder, made from a mixture of broken crucibles, firebricks, sand, crushed quartzite, coke, graphite, etc., and used for large castings, is unknown in America. A similar product is, however, used in iron molding. Large steel castings are prepared in molds made from the same sands as small ones, but the composition is altered as required. Usually the bond is made somewhat stronger and silica flour is added to maintain the refractoriness. Castings weighing as much as 230,000 pounds are thus made.

In the best British practice small molds are not painted, and the surfaces of large ones are washed over with either "silica-paint" or a wash prepared by mixing compo with water and allowing the coarse material to settle. In the United States silica paint only is used, and most frequently molds of all sizes are painted. Painting is supposed to insure the production of a good skin upon the castings, and easy stripping from the sand. In the case of small castings, it is a matter of opinion whether paint assists the stripping by preventing burning-on of the sand, or is conducive to soundness in the casting. In America silica paint is generally prepared as a viscous fluid from silica flour and water with the addition of molasses, flour, glutrine and in some cases common salt. Silica flour alone is sometimes dusted over the mold. The use of tar as a paint on large molds has almost died out in Britain, and was nowhere observed in America.

The nails used in sprigging the molds in American foundries are much larger than those employed in Britain. They are also used much more extensively. Sometimes the mold is studded with them. Apart from strengthening the structure, they also serve to conduct away the heat, but their excessive use seems to be undesirable and expensive. It may, however, be related to the weakness of the bond, as compared with that of European sands.

The venting of American sands does not appear, in most cases, to be so thoroughly accomplished as at home. In the case of the naturally bonded sands in the Eastern states, the grain of the sand grade in the natural mixture is smaller than that of Belgian and British sands. More need, therefore, exists for the opening up of New Jersey sand with coarse silica sands. In the few works where effective venting is secured, the improvement in soundness of the castings becomes evident.

The arguments adduced in favor of the practice of using artificially bonded silica sands are such that the writer is inclined to recommend the more extensive use of what might be termed synthetic steel molding sands. In order, however, to retain the excellent bond and stripping power of the sands, and the consequent good skin of the castings, it will be desirable to discover and use natural supplies of colloidal hydrated iron oxide (ochre) or compounds with similar physical characteristics. Here are problems for laboratory investigation and works experiments. Such an opportunity for standardization should not be ignored, but, on the other hand, the difficulties of the problem should not be underestimated.

More Standardization Desired

The introduction of repetition work into a foundry saves both time and labor, and increases production. It is evident that while it may not be feasible to standardize a number of foundries scattered over the country, using, perhaps, somewhat different materials, and faced by differing local labor conditions, yet there is room for a greater amount of standardization in each individual foundry. The introduction of far more molding and ramming machines into the foundry is a case in point. Molding sand practice leads itself to experimenting upon these lines, but there is a limit to the uniformity attainable, for it would be deplorable if anything were done to reduce the individualism of the trained foundryman—his skill, predilections, experience and traditions; and it is in this direction that the writer feels that the British foundryman is still ahead of his American brother. Prejudice must not be allowed to reduce this lead. The smaller individual output, not always due to more thorough work, threatens seriously to eliminate it. This is doubly unfortunate in view of the fact that the most urgent question facing the foundry industry is the speeding up and increasing of production in every department.

In conclusion, the writer gladly takes this opportunity of recording his thanks to the numerous American gentlemen who gave him such a cordial reception and opened their works to him without reserve. It is to be hoped that American visitors to Britain will in the future be accorded at least the same facilities, and as hearty a welcome.

Move Head Office to New York

The Chicago Pneumatic Tool Co. plans moving its general offices from Chicago to New York and toward this end is erecting an office building at 6-8 East Forty-fourth street, New York City.

The structure, which is being built by the Westinghouse Church Kerr Co., New York, is of combination steel, brick, and limestone, and will comprise initially 10 stories, all to be occupied by the company.

The operation of the company's six American plants and 26 sales and service branches can be directed more economically from New York. There will be continued in Chicago a sales and service organization more extensive than formerly. The new building is to be ready for occupancy early in 1920, at which time the transfer will be effected.

The T. W. Price Engineering Co., Woolworth building, New York, is engaged in making plans for a large foundry for making cast iron pipe, by the new process known as the "centrifugal cast iron pipe process," which has proved successful in an installation at the plant of the National Iron Works, Toronto, Can.

A soldering paste for use in soldering aluminum, patented by H. C. Proctor, consists of powdered rosin, 75 per cent; vaseline 20 per cent and ammonia, 5 per cent.

Molds Made by Centrifugal Method

In Order to Attain Maximum Efficiency it is Necessary That Molds be of Sufficiently Heavy Section That Repeated Use Will Not Bring Them to Red Heat

By J. E. HURST

As a result of the desire to avoid the destruction of the mold after the completion of each casting, permanent molds of various types are employed.

The system of pressure die casting is not being applied commercially to ferrous castings, and the author is not aware of any extensive experiments in this connection. The production of castings in cast iron by the centrifugal process, however, might be classified under the heading of pressure die-casting.

It is the author's experience that the occurrence of pinholes in cast iron die castings made in stationary dies is entirely a question of the temperature of both the metal and the die, and is not influenced by the cast-iron die unless, of course, this is in a very badly disintegrated state.

In certain circumstances cast-iron dies have been known to crack after being in use for a very short time. In these cases the cracking can for the most part be traced to defective design of the dies, and also to the presence of internal defects such as blowholes and porosity in the die material. Defective design resulting in the production of uneven internal stresses is more frequently met with in dies of complicated design. Apart from such cases the failure of dies takes place by a peculiar form of surface cracking and disintegration, which ultimately results in the complete fracture of the die.

The rapidity of the initial formation of surface cracking in dies depends entirely on the maximum temperature attained by the die in use. Growth commences at temperatures of from 650 degrees to 700 degrees Cent., or at quite a red heat. If the dies are allowed to attain this temperature the surface growth will rapidly take place. It is necessary, therefore, to have the dies sufficiently thick in order to prevent this temperature being regularly obtained under the particular conditions and rate of casting in vogue.

Messrs. Rix and Whittaker, as a result of their experience with aluminum-bronze die-castings, in which the die temperatures attained are quite comparable with those of cast iron, state that the life of dies in their practice was approximately 5000 castings.

Distortion troubles also can frequently be attributed to defective design of the die, resulting in the heat producing internal stresses, setting up the strains which ultimately result in the permanent distortion, and frequently cracking of the dies as noted.

Apart from the effort of bad design, permanent distortion in the mold appears to be due to the gradual decomposition of the combined carbon. The internal stresses set up as a result of the volume changes result in the gradual permanent distortion of the mold.

The best method, in the author's experience, of reducing these troubles to a minimum is the use of an iron with an extremely low combined carbon content.

In the production of the die blocks of cast iron, closeness of grain is quite an essential feature, as this tends to minimize the rapidity of surface growth. The production of very low combined carbon material, at the same time accompanied by a very close grain, is frequently a difficult matter, particularly in thick dies cast in sand. The use of chilled molds is therefore advisable for the production of cast-iron die-blocks of low combined carbon.

The temperature to which the die is subjected appears to have little ultimate influence on the distortion as whatever the temperature the combined carbon content is ultimately decomposed, particularly if the silicon is in excess of 1.5 per cent.

Iron castings made by the centrifugal method of casting might be considered as belonging to the die-castings class. For many reasons, however, it is preferable to consider such castings as belonging to a separate class, and the author prefers the distinguishing title of centrifugal castings.

In the centrifugal process, castings are produced by introducing the molten metal into a metal die, or permanent mold, which is rotated at a high speed. The molten metal takes the required form of the mold as a result of the centrifugal action due to the high speed of rotation.

Most castings having a cylindrical internal form can be produced by this process. The external form need not necessarily be strictly cylindrical, and castings having considerable variations in the shape of lugs, projections, and fins on the external face can be produced by this process.

Some of the advantages of the centrifugal process over ordinary die and sand castings are said to include: Absence of gates, runners, risers and feeder heads; the entire absence of cores; the ease and rapidity of production; the absence of necessity for cleaning.

Die-cast iron castings possess distinct advantages over ordinary sand castings, in the author's opinion. The foremost advantage is undoubtedly the extremely fine grain size.

The grain size of any fine composition cast iron is, generally speaking, a function of the rate of cooling. The more rapid the rate of cooling the smaller the grain size. By the use of metal dies the rate of cooling of the cast iron is considerably increased, with a resulting increase in the fineness of the grain. The obvious danger is the possibility of the rate of cooling being sufficiently fast for chilling to take place, giving the castings a hard unmachinable white-iron skin. This, however, can be avoided by a suitable adjustment of the composition of the iron, the thickness of the mold, and the temperature of the metal and mold before pouring.

The foundry, as an occupation for a large majority of our brainy youths, is very frequently passed over as being a "filthy job." This is due largely to the employment of sand as a molding material. From an aesthetic standpoint alone, therefore, the more extended use of permanent molds or dies is warranted, and it seems certain that this would assist in the future development of the craft.

Abstract of paper presented at the July, 1919, annual conference, British Foundrymen's association, Liverpool, England.

The Lumen Bearing Co., Buffalo, expects soon to build a plant at Youngstown, O., where mill bearings and other heavy brass castings will be made to supply increasing demand.

Castings for Ship Construction — IX

Suggestions For a Different Design in a Standard Propeller-Bracket Pattern Are Offered, and Full Details Concerning the Building up of Barrel, Arms and Palms are Presented

By BEN SHAW and JAMES EDGAR

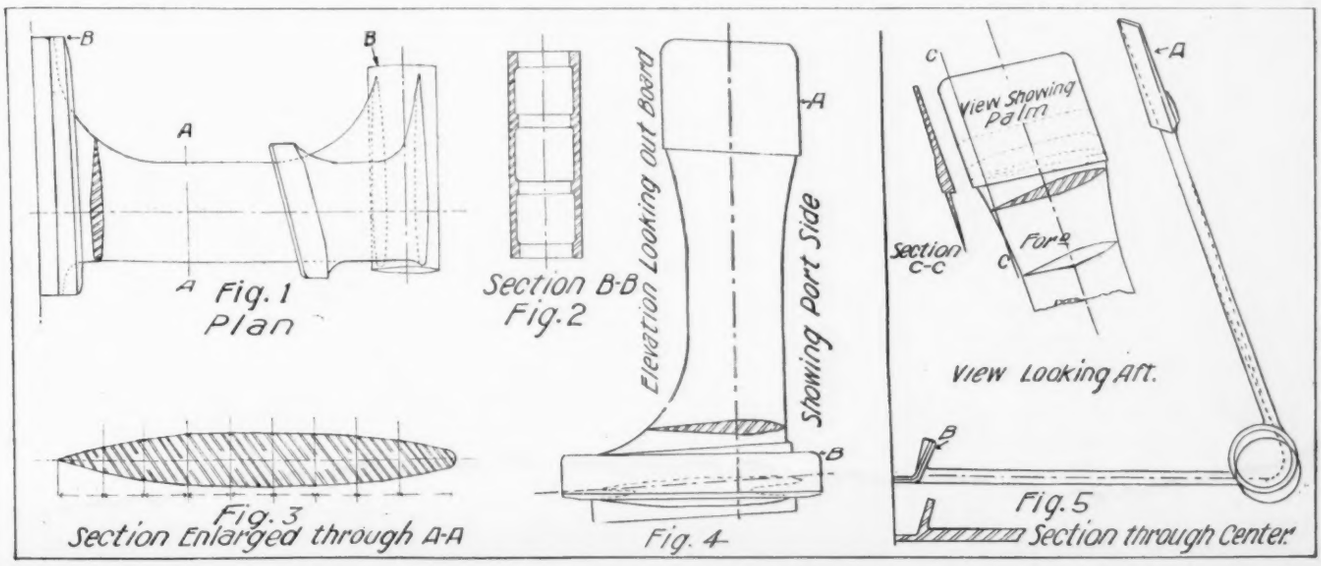
ALTHOUGH the design of the propeller bracket shown in Figs. 1 to 5, resembles in some respects the one described in the previous article, it differs in some important details. The section of the arms or fishbacks is the same in both cases, except that in the bracket under consideration they are not cored out, but are cast solid. These brackets sometimes are called A-frames, because of their shape. It will be observed that the boss in this case is long, and the palms are, of course, quite different. It might be possible to make the pattern for this bracket in a similar way to the one already described, that is, by building two mocks on the floor, fitting the arms between them and the boss, after the palms are finished. But this would be a clumsy task. It would be difficult to secure accuracy, or to get a job sufficiently strong to withstand the wear and tear in the foundry.

It is possible to build this bracket in a position corresponding to that which it will take in the ship. The construction of the pattern requires great care, because of the angles of the arms in relation to the boss, and the angles of the palms in relation to the arms. It would be inadvisable, even with the most careful workmen, to allow a bracket pattern to go to the foundry without a careful examination. An idea of the difficulty of making the bracket pattern is obtained when it is pointed out that the barrel for the boss is sometimes 25 feet long.

Sketches of the templates supplied by the molding loft are not given, because they are similar to those for the propeller bracket described in the previous article. A template is made for the arm section. In this case the arm does not taper in thickness toward the palm, but is of uniform section throughout. The angle of the boss is given by a template. This rectifies any discrepancy between the drawing and ship. A template also is necessary for both shape and angles of the palms, while a large template defines the angles of the arms to each other. It is not necessary to set the job out in full on the floor. The better way is to make full size views of each arm on a drawing board, and either set out center lines of arms and boss on a drawing board or on the floor. It is necessary in order to economize when getting out lumber, to make scrap views of fillets, palms and parts of the barrel. As only the best lumber can be used on such work the importance of economizing is great.

The boss for this bracket is long so it is necessary to provide two lifting bolts and the stays (*A* Fig. 6) should be made about three inches thick, and four or five inches wide. The lumber should be placed perfectly straight, for if it is warped in the length it will be impossible to make a true barrel. It is good practice to get out all the timber for such a job at the beginning, cutting it to approximately correct widths and thicknesses. Even a comparatively straight grained board will change its shape when reduced in thickness or cut into widths. But if cut to the correct thicknesses and widths, and allowed to lie for a day before being planed it will be less subject to distortion. In some patternshops this is the charge hand's work, after he has set down the job, and apart from the saving in lumber it compels him to master the details of the job thoroughly at the beginning. It is not possible, however, to adopt this practice with some jobs, where every piece of lumber has to be cut separately and fitted. The rings or grounds should not be more than 20 inches apart. As the lifting bolts—usually 1¼-inch bolts—will drop down toward the outside of the barrel, special stays like *B*, Fig. 6, should be checked into the rings. These form guides for the bolts.

It is not well when making such a heavy barrel to rely on the stays



FIGS. 1, 2 AND 3—PLAN AND SECTIONS OF TYPE OF PATTERN FOR A PROPELLER BRACKET FIG. 4—ELEVATION OF PATTERN FOR PROPELLER BRACKET, LOOKING OUTBOARD FIG. 5—VIEW LOOKING AFT, WITH DETAIL OF PALM

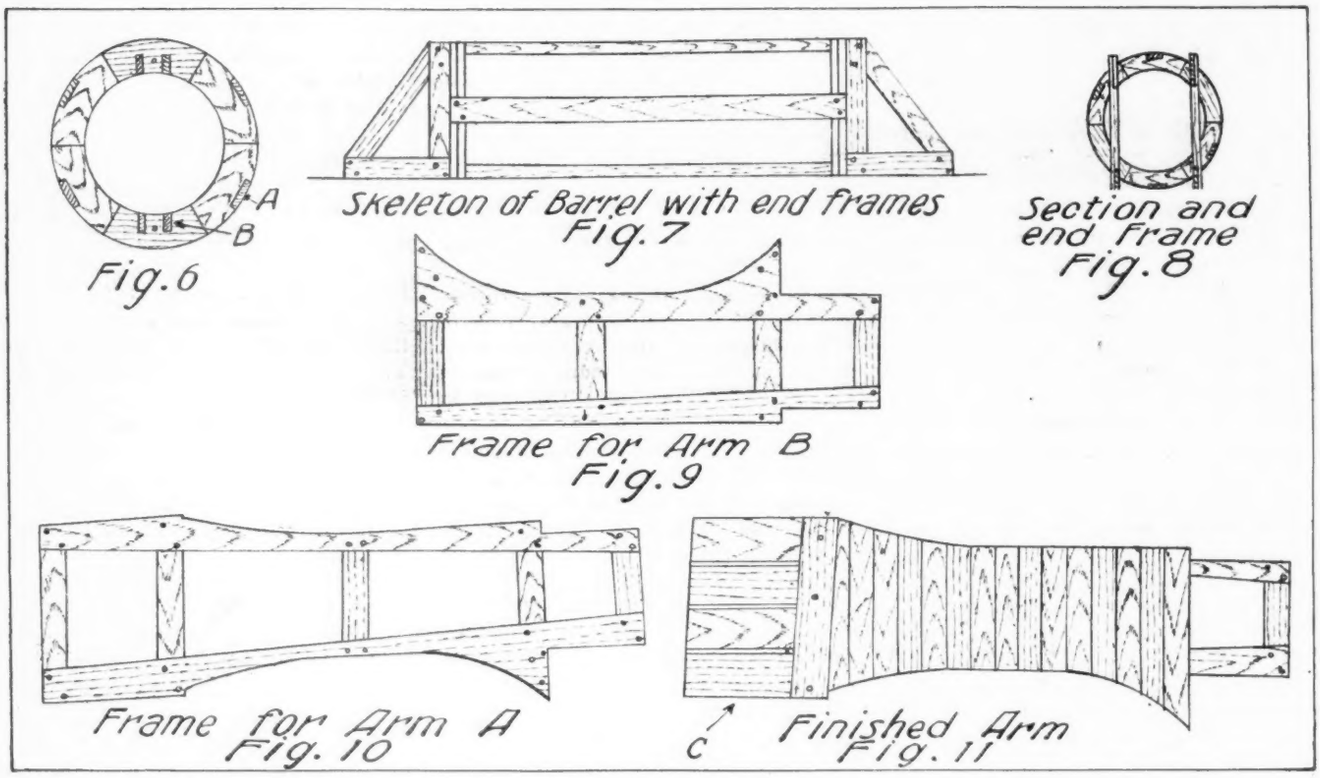
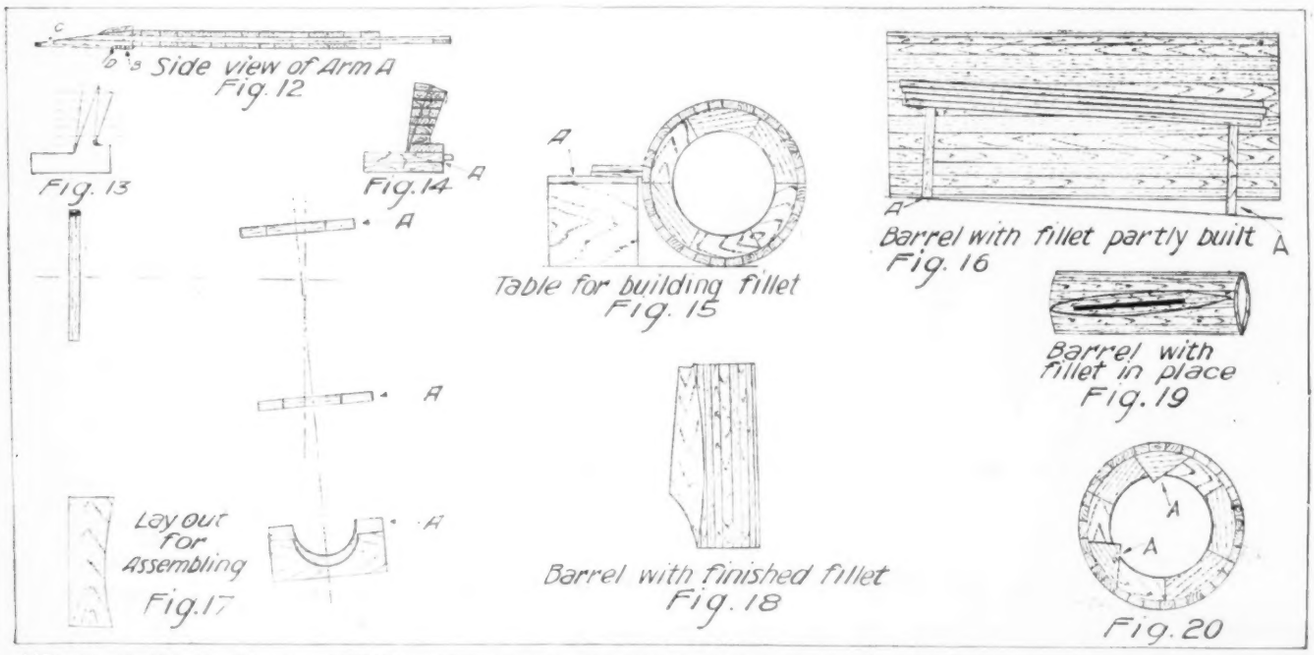


FIG. 6—BOSS FOR PROPELLER BRACKET PATTERN, SHOWING THE LIFTING BOLTS FIG. 7—SKELETON OF BARREL WITH END FRAMES FIG. 8—END VIEW OF SKELETON BARREL SHOWING END FRAMES FIG. 9—FRAME FOR ARM *B* FIG. 10—FRAME FOR ARM *A* FIG. 11—FINISHED ARM

while fastening the lagging. Cross center-lines should be drawn on the rings, and the skeleton fixed on the floor with end triangular frames, Figs. 7 and 8. It is a simple matter to screw straight edges across the center lines on each end, on which to try a level. It is necessary, of course, to pack one end ring underneath, as each ring is of a different diameter owing to the taper of the barrel. A few diagonal stays usually are fitted inside the skeleton between the rings before the lagging, which ought to be 1½ inch or 2 inches thick, is screwed on. The lagging for such a job should be open jointed. When half of the barrel has been covered with the lagging, the triangular frames can be safely removed and the remainder of the lagging fixed. The frames for the arms, Figs. 9 and 10, differ from each other because the palm *A* in Figs. 1, 4 and 5, is built on the center frame, while the palm *B* is made separately and dowelled on. The fillets would be too un-



FIGS. 12, 13 AND 14—SIDE AND SECTIONAL VIEWS OF ARM SHOWING THE JOINT OF THE PALM FIGS. 15 AND 16—TABLE FOR BUILDING FILLET AGAINST THE BARREL FIG. 17—ARRANGEMENT FOR ASSEMBLING THE VARIOUS PARTS OF THE PATTERN FIG. 18—BARREL WITH FINISHED FILLET FIG. 19—BARREL WITH FILLET JOINED IN PLACE FIG. 20—ARRANGEMENT OF BLOCKS INSIDE THE BARREL FORMING SQUARE FACES FOR NUTS

wieldy if completed separately from the arms. A better way is to form part of the fillet on the arm. The arms should be fixed by hook bolts, the hooks gripping the frame of the arms, and the bolt penetrating to the inside of the barrel. Of course a guide has to be formed for the arm, and this is done by making the frame act as a dowel into a recess in the fillet. The center frames should be stoutly made. The portion at the boss end forming the dowel should be the depth of the part of the fillet which is fastened on the boss. This should be a foot or more, depending on the length of the arm.

The best way to build the arms is to screw pieces across the frame. These pieces are straight, and can be sawed and sand-papered to shape from a template. The fillet portions can be sawed roughly and finished off after the whole arm is built. Although in the sketch, Fig. 10, the arm *A* is shown the full length, the actual length is determined by the edge view. Thus in Fig. 12, it will be seen that the bevel on the back of the palm requires the frame to be made short. It is long enough, however, to support the thicker pieces *C* which have to be screwed on the face and left open-jointed. A portion of the face *B*, shown in Fig. 12, has to be left loose with a long taper at *D*, the purpose of which will be explained when the molding is described. To complete the arms *B* the flange or palm has to be finished and dowelled on. If a view like Fig. 13, is drawn, showing the shape on both ends of the palm and cross lines 1 inch apart are set down on it, 1-inch lumber can be used for constructing it, and each thickness finished, before it is fastened on. This is both a quicker and more accurate method than building lumber roughly and shaping it finally. The face *A*, Fig. 14, which joins the arm, has to be planed so that the angle of the palm will be correct. Care must be taken also when inserting the dowels. If centers are drawn on each face, there should be no difficulty. It is necessary to trim the edges when the palm is dowelled on. This will have to be screwed as well as dowelled to keep it rigidly in position while the molder is ramming sand around it.

Building the fillet is the most arduous task of all. It has to be built in position on the barrel, and the finishing has to be done after it is built. The jointing of the lumber depends greatly upon the size, and the shape of the fillet, and no hard and fast rule can be applied to all cases. It is wise, of course, to feather-edge such fillets, where they join the barrel with the end of the grain. It must be remembered the fillets are not glued on, but have to be left loose, that is with screws inserted which can be withdrawn, allowing the barrel to lift from the sand. Screws may be put in from the outside temporarily, but after the fillets are built, and before they are cut, it is more convenient to screw them from the inside of the barrel. This is easy, as the barrel is large enough in diameter to permit a boy or man on the inside to use a screw driver. Each fillet will be considered separately. When the longitudinal center line of the barrel is set down on the floor, and a line corresponding to the face of the fillet is also drawn with the center line of the arm bisecting it, the barrel will have to be lifted on saddle pieces, so that the fillet can be built with a level center. This is necessary because the cross centers of the arms are not on the same plane as the horizontal center of the boss. Fig. 17, which shows the arrangement for finally assembling the various parts will give the arrangement for building the fillet. The saddle pieces *A* are first screwed down, and the barrel rested on them and retained in position by screws or battens on the ends. A table, *A* Figs. 15 and 16, has to be made for building the top part of the fillet, and the first piece of lumber will correspond with the line of the top face of the arm frame. This will assure the recess for the dowel being correct.

A rough outline of the elliptical shape formed by the junction of the fillet with the barrel should be drawn on the latter. This is not a difficult matter as width and length are given on the working drawing, and as it has already been said the shape between is largely a matter for the craftsman's judgment. The line for the face of the fillet should be squared from the floor to the top of the stave. In building the layers of lumber for the fillets glue should be used, as not many screws can be left in while shaping.

When the top of the fillet is built the table is removed. Two pieces, exactly the same thickness as the arm should form the next layer, and

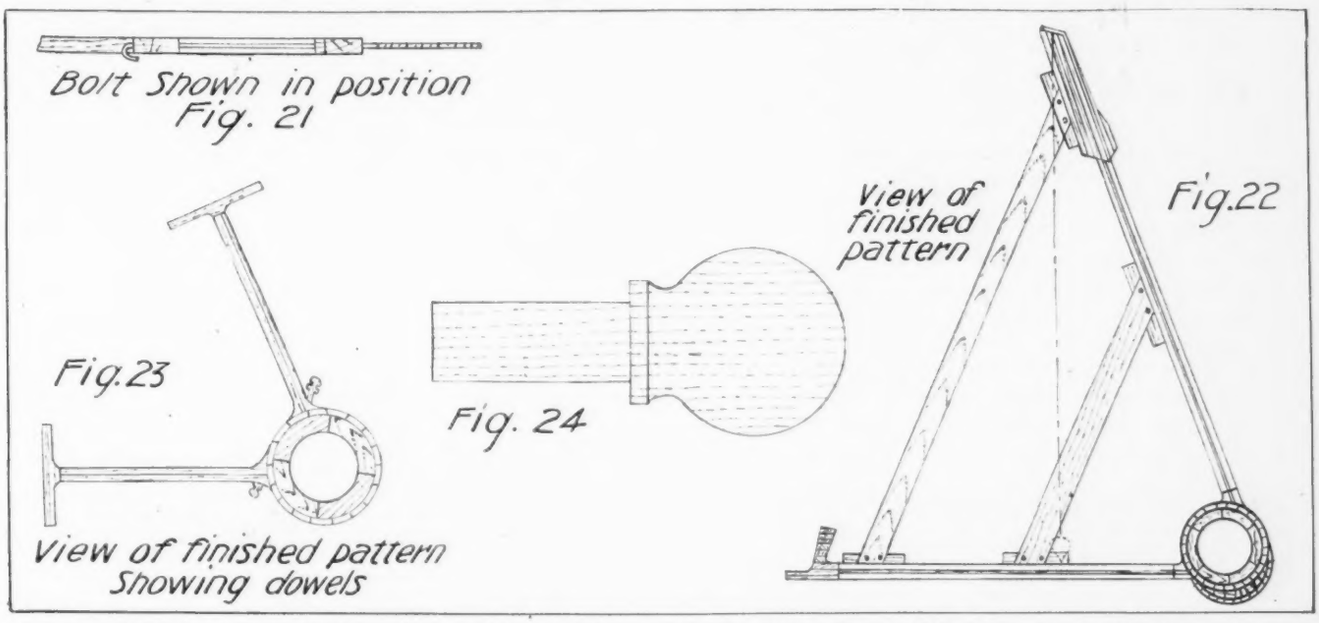


FIG. 21—HOOK BOLT SET IN POSITION FIG. 22—PROPELLER BRACKET PATTERN COMPLETED AND ASSEMBLED FIG. 23—COMPLETED PATTERN SHOWING THE USE OF DOWELS FIG. 24—DETAIL OF SUITABLE FORM OF DOWEL

the space between them will correspond with the width of the arm dowel. The bottom then can be built in a manner similar to the top. Some short laths of very straight grained pine and about ¼-inch square are a great help in shaping the fillets. This is better than to rely entirely on sight and touch, as both hand and eye fail to detect slight flats and lumps, after the craftsman has been working at the job for some time. Wherever the lath is tried on the fillet it should bed along its entire length. Sometimes these large fillets are built in four or more sections for convenience in handling, both in the patternshop and in the foundry, as the fillet must be drawn into the barrel space in the mold. This advantage, however, is balanced by the extra trouble in jointing and screwing the sections together after each cast. Jointing also destroys the reliability of the fillet as a guide for the arms. When the barrel is long the fillet extends from end to end, and it might be wise in such a case to make the fillet so that the top above the dowel can be drawn into the barrel separately from the bottom. When a fillet is made the barrel should be turned around and the other fillet built in a similar way. In this case new saddle pieces have to be made, and probably a new table, as the angles will be different. The careful workman will put on all the necessary center lines for both fillets, and make the tables and saddle pieces, before he begins the construction of the fillets. A slight error in these fillets will produce a big error in the length of the arms. Two views of the barrel with a finished fillet are given in Figs. 18 and 19.

It would be impossible to bolt the arms to the barrel unless provision is made for the nuts inside the barrel. Blocks *A*, Fig. 20, should be built and screwed inside to form a square face for the nuts. When the bolt holes have been bored the whole pattern is ready for assembly. The saddle pieces which were used for making the fillets are used again. The barrel should be set as it was when making a fillet. This means that in the length the arm will be level. A saddle piece should be made for the arm to rest in. The arrangement of these saddle pieces on the floor is shown in Fig. 17. The hook-bolts, two for an arm, are fixed as in Fig. 21, and when the arm is pushed into its position the nuts can be screwed on the inside of the barrel. In addition to the bolts it is as well to put in some temporary screws on the outside. The arm may be removed, and the barrel set to receive the other arm. It is advisable to bolt both arms in their positions resting on the floor. When the second arm has been fixed it is not necessary to remove it. The other arm is hoisted into position with a block and tackle or a crane, but as it has been in position it is not difficult to replace. The completed pattern is shown in Fig. 22. It is probable that the top arm will droop a little, unsupported. Stays are fitted between the arms to prevent this. It would be awkward to make and fit a half-lapped frame between the arms. The stays which are shown in the sketch should be dowelled and also screwed to blocks fixed on the arms. Before the holes are bored, however, the arms should be tested for position.

The distance between the tips of the arms on the centers can be obtained from the floor, and the work tested with a steel tape. The best test, however, and the only one which probably will satisfy an inspector, is to drop a plumb line from the center of the top palm to the floor, or the top of the other arm as the case may be, the center having previously been marked. If reasonable skill has been expended in making and marking off the various parts, there will be no inaccuracy.

If the work is large it is much better to disassemble it and convey it to the foundry in parts, where it can be put together easily and quickly. The screws which must be drawn by the molder to get the fillet and the arms withdrawn from the mold, have to be painted round, so that none will be unnoticed and left in. Molders do not always remember to try if they can get every piece free, before bedding a pattern in the sand, although they should do so, and as with other steel castings, if square corners are wanted anywhere because of the plating, the fact should be written distinctly on the pattern.

For small brackets of this type, or even of the type described in the previous article, the arms may be constructed and fixed to the boss in another way. Where the arms are only 3 or 4 feet long it would be manifestly absurd to so build them. They may be bolted to the barrel, and it might not be possible to dovetail them. The usual practice and probably the best is to make a solid arm of two or three thicknesses of timber and screw extra thicknesses at the ends for fillets. When this is done the whole can be shaped at one operation, and fitted to the barrel. Screws will hold it quite rigid, but it will be a great convenience for the molder if dowel pins are put through the fillet into the barrel. These dowels should be 1½ inches or 2 inches in diameter, and with a good handle so that they can be withdrawn easily. A suitable form of dowel is shown in Fig. 24, and such a pattern shown finished in Fig. 23. It is often possible with these smaller brackets to screw the palms to the ends of the arms, either leaving the molder to arrange for the fillet, or making the fillet separately against the arm and palm so that it can be drawn in. If the foundry is near at hand and the patternmaker can be in attendance, or can be consulted by the molder, some details can be left, although it is wiser, within practical limits, to leave as little to the foundry as possible. After all, the patternmaker is working to a drawing, and it is not quite fair to the molder to expect him to know what is wanted, when he has not the opportunity to study the drawing.

There is no difficulty with the shaft core for the bracket, a plain board being all that is necessary.

Types of Foundry Buildings Described

The Austin Co., industrial engineers and builders, has just issued a new booklet known as catalog No. G. It contains cross-sections of the company's ten standard types of buildings and gives a description of Austin service to foundry and steel plant owners.

The object of this booklet is to condense the description of the Austin company's complete building service to a booklet that can be read in four or five minutes and that will fit the pocket conveniently.

New Core Binders

A new form of dry core binder has been developed by Corebind, Ltd., 5 Castle street, Finsbury, London, E. C. 2, England, and arrangements are being considered for marketing this product in the United States. Since the powder is furnished in dry form, it can easily be mixed with the sand in correct proportions even if the sand is already moist. The proportions of binder necessary vary from 1 to 20 to 1 to 40 according to the nature of the sand used.

A recently patented mixture for making molds for casting light metal articles is made of plaster of paris, 40 parts; asbestos fibre, 30 parts and brick dust, 30 parts.

Bethlehem's Ingot Mold Foundry

Direct Metal From Blast Furnaces as Well as Cupola Metal is Used—Arrangement For Storing and Charging Coke is Unique—Molds Are Poured From a Long Platform

By E. C. KREUTZBERG

PRIOR to the tremendous expansion in the steel production facilities of the Bethlehem Steel Co. during the past few years, all of the ingot-mold requirements of the company were taken care of by the iron foundry at the Lehigh plant. This foundry had sufficient capacity to produce 4000 to 4500 tons of ingot molds per month. After the Bethlehem Steel Co. took over the properties of the Maryland Steel Co., the Pennsylvania Steel Co. and the American Iron & Steel Mfg. Co., the capacity of the foundry at the Lehigh plant became wholly insufficient, and it became necessary to purchase a large portion of the ingot molds required for the operation of the various works.

In order to meet the needs resulting from this expansion, the erection of a new ingot-mold foundry was undertaken at Bethlehem. This plant, which only recently was completed, is an unusual establishment. Its capacity is 10,000 tons of ingot molds, stools and bottom plates per month. This output not only is large enough to supply the full requirements of the Bethlehem Steel Co. plants at Bethlehem, Sparrows Point, Lebanon and Steelton, but 30 to 35 per cent of the total capacity will be available to other eastern steelmakers. The new ingot mold foundry contains about 85,400 square feet of floor space, has a maximum length of 550 feet and a maximum width of 272 feet. Of this area, a 75 x 275-foot space is given over to the raw material yard which, unlike the stock department in most foundries, is completely covered by a roof. Of an unusually substantial character, the foundry building has a steel frame, brick walls, a poured gypsum roof and other details which make it thoroughly fireproof.

Mixer Metal Used

Due to the general plant layout at Bethlehem, the ingot mold foundry is arranged for handling both hot metal and pig iron. Hot metal is obtained from blast furnaces which supply all other departments of the plant; hence a supply of hot metal cannot at all times be obtained at the moment it is required. For this reason arangements were made for melting pig iron when hot metal cannot be obtained. Two cupolas, each with a capacity of 40,000 pounds per hour, and one 450-ton mixer comprise the equipment for providing metal at this foundry. Of the raw material for the cupolas, 90 per cent is bessemer pig iron made by the Bethlehem Steel Co. in its own blast furnaces. The remaining 10 per cent comprises scrap originating in the various departments of the company. The mixer, shown in an accompanying illustration, is of standard construction. It is equipped for burning oil or by-product coke oven gas, and hot metal may be maintained in it at a satisfactory temperature for any desired length of time.

The arrangement for handling the charges for the cupolas and for facilitating their operation generally is of considerable interest. For serving the cupolas, there are two platforms, one at the level of the spout and the other at the charging level. Pig iron and scrap are loaded into flat boxes which are brought to the charging platform

FIG. 1—MOLDING FLOOR AND PIT SHOWING EQUIPMENT FOR PRODUCING INGOT MOLDS AT THE NEW FOUNDRY OF THE BETHLEHEM STEEL CO.

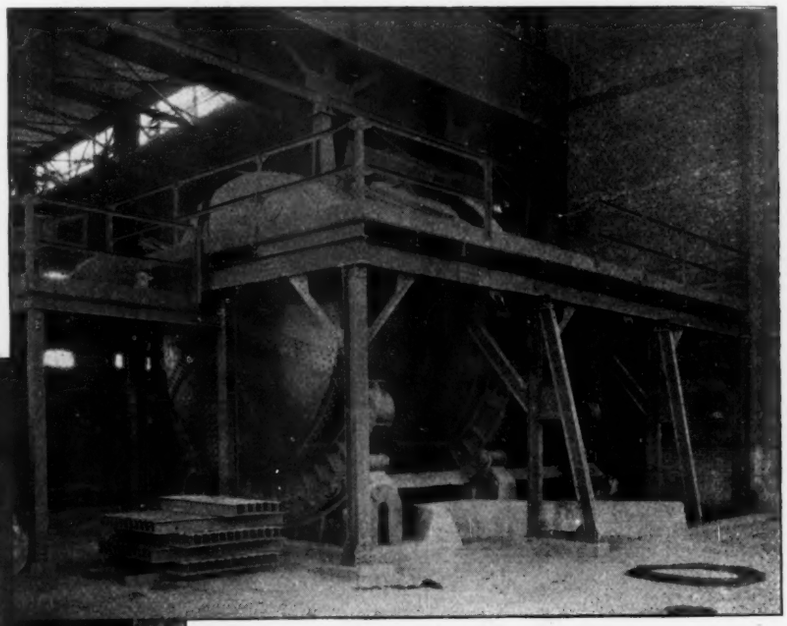


Fig. 2—Coke is Elevated to Bins Above the Charging Floor From Which Measuring Buckets Are Filled for Charging the Cupola, in Order to Save Labor in Handling.

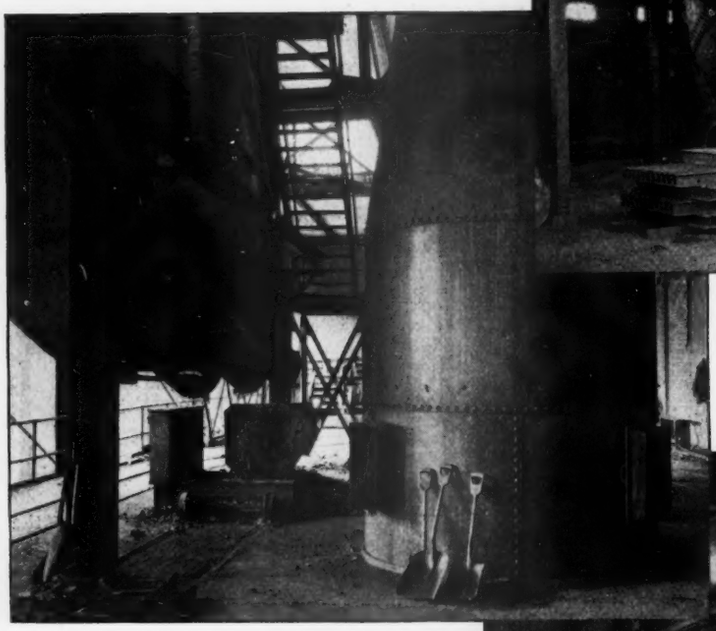


Fig. 3—The Cupolas are Elevated so That the Bottoms May be Dropped Directly Into Cars Instead of on the Floor, Thus Saving Expensive Handling.

Fig. 4—The Foundry is Equipped With a 450-Ton Mixer Which is Charged With Molten Metal From the Blast Furnaces.

Fig. 5—The Molds Are Dried in Double-Ended Ovens From Which They Emerge Onto the Pouring Floor, Where They Are Placed Alongside the Pouring Platform.

by means of two 25-ton cranes which span the raw material yard. On the charging floor they are placed on buggies which are pushed in front of the charging doors where the pig iron and scrap are charged by hand to insure proper distribution of fuel and metal. All iron is charged by weight; fuel, however, is charged by volume.

How Coke is Handled

The iron is charged through doors at the front of the cupolas and the fuel through doors at the rear. Fuel is delivered to the foundry in cars which are spotted over track hoppers and from the bottom of the hoppers the cope is conveyed by a skip hoist to bins above the charging floor. These bins are three in number and each has a capacity of 30 tons. From the bins the fuel passes into fixed-volume buckets, the flow being controlled by means of gates at the bottoms of the bins. In order to facilitate the removal of refuse from the cupolas, the latter were built at an elevation so as to afford ample clearance for cars which are spotted beneath them at the conclusion of each heat. Into these cars, which operate on rails, the bottom is dropped and the cars then are pushed to a dump where their contents are discharged. This system greatly decreases the amount of work necessary around the cupolas and accordingly cuts down the cost of operation. In order to have a clear space beneath the cupolas, the bottom doors are kept in place by pneumatic plungers, which are released at the time of dropping.

On the molding floor, specially designed 3-part flasks are used. The flasks are cast iron. Unlike the practice at many plants where the spindle is molded separately and set on the bottom plate, the Bethlehem Steel Co. molds the bottom and spindle as a unit. In this operation, the spindle is set in place and keyed to the cast-iron plate, after which the sand bottom is rammed. Next, the pattern is set in place over the spindle, being maintained rigidly in position by the use of an arbor which fits inside the top of the pattern and centers it about the spindle. The flask then is lowered onto the bottom, after which sand is filled in between the spindle and the pattern, and between the pattern and the flask, both being rammed together. The flask is then lifted and the pattern drawn. The ramming of the molds is done in pits, and the molding of the bottom and spindle in one piece results in a smooth casting since this method prevents the formaton of fins which result when the spindle is not integral with the bottom.

From the molding pit the molds are transferred by cranes to the drying ovens. There are eight of these ovens, each 12 x 25 feet. They are of the car type and are fired with by-product coke oven gas. The entrance to these ovens is on the molding side and the exit, from which the dried molds are discharged, is on the pouring side of the shop. On being withdrawn from the ovens, the molds are assembled alongside a raised concrete pouring platform 7 feet wide and 175 feet long. Each mold, when rammed, is provided with a sprue reaching from the top down to the bottom in order that the casting may be poured from the bottom. In order to pour without causing injury to the mold, through spattering of the metal, the sprue is surmounted by a large sand box.

The use of the concrete pouring platform supercedes the old method of pouring in pits. It has been found that the platform makes it possible to assemble, finish and pour the molds with greater facility and a greater degree of safety than is possible with the pit pouring method.

FIG. 7—THE STOCKYARD IS ENTIRELY PROTECTED FROM WEATHER AND IS COMMANDED BY CRANES WHICH LIFT THE CHARGE FROM THE CUPOLA PLATFORM

General Equipment

In addition to the cranes in the raw material storage yard, the casting and cleaning section of the foundry is provided with one 40-ton and three 25-ton cranes. The mixer department is provided with a 100-ton ladle crane and the molding shop with three 25-ton cranes. The foundry is provided with a sand mixing screen and with a pneumatic system for conveying molding sand to the various floors. A 30 ton jar-ramming machine has just been installed for ramming the molds.

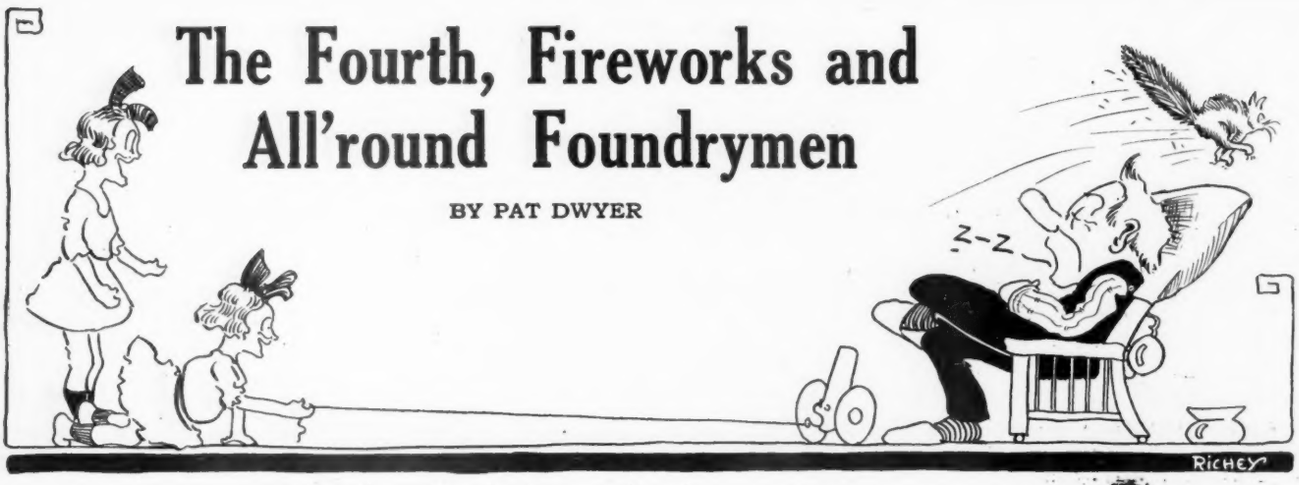
The foundry is provided with a full equipment of flasks large enough to produce molds for ingots ranging all the way from 6 x 6 inches up to 22 x 80 inches. Ingots of the latter size weigh 34,000 pounds each. The foundry equipment includes a wet pan for mixing material for luting the cupolas and also for mixing foundry facing.

The foundry is provided with the necessary equipment for finishing cast-iron flasks, including a planer, a radial drill and other machinery. Scales are at hand for weighing the individual molds as well as for weighing carload shipments of molds and of raw materials.

FIG. 6—AFTER COMING FROM THE DRYING OVENS THE MOLDS ARE SET UP ALONGSIDE A 175-FOOT CONCRETE PLATFORM ON WHICH THE OPERATOR STANDS WHEN POURING

The Fourth, Fireworks and All'round Foundrymen

BY PAT DWYER



ON THE evening of July 4, which is also known and referred to in these United States and outlying island possessions as Independence Day, I went for a stroll in the park with the ultimate object of viewing the fireworks. Not verbal fireworks, but the real old simon pure article, rockets, pin wheels, nigger chasers and roman candles. The younger members of the family had brought home glowing accounts during the day of the progress of the work. Every step in the process of setting up the frames and scaffolds for the set pieces was carefully noted and reported upon. The evening meal was hurried through and we were on the way.

I was accompanied on this excursion by two charming young ladies who made up in volubility what they lacked in stature. I have been paying these young ladies' room and board bill for several years. I even buy clothes for them occasionally and if the shoes I bought for them were placed end to end they would reach from Fire Island light to the Golden Gate.

They arrived at our modest home within a few years of each other, without credentials of any kind. In fact they brought nothing, not even the clothes on their backs. My lady wife, who is a suspicious nature where strangers are concerned, waived all ceremony on their account and welcomed them quite effusively. I thought, at the time, that she was rather over enthusiastic considering that their appearance was a trifle unprepossessing—if you know what I mean. In the course of time I have come to share her enthusiasm and now I am as willing to uphold their claims to feminine pulchritude as any knight of the olden time who laid a spear in rest to prove the superior charms of his lady love. From occasional remarks which I have heard these ladies make, especially on pay-days, I am led to believe that the feeling is reciprocal. All of which of course is very interesting to me, but what do you care? Nothing.

We went down to the park and after strolling around for a while we found a nice grassy spot and sat down. The crowd began to gather and one of the young ladies ventured the opinion that there were about a million people present. I was doubtful. I told her I was not in a position to give her the exact figures but I was quite positive it was not a million. "Well, then," said she, "half a million?" Judging from my expression that I did not agree with her she compromised by saying, "It is the biggest crowd *I* ever saw." I told her she was perfectly right, that was just about the exact size of the crowd.

There was music by the band, speeches by prominent citizens, and community singing. In a booth nearby a gentleman and his wife lately from some place in central Europe, dispensed ice cream and carbonated beverages. Needless to say the drinks were not sold under a good old sterling Anglo-Saxon title. The same process of evolution that is gradually wiping out the predominance of any one race or nationality in this country is also playing hob with our language. How else do you account for the fact that drinks which were known a few years ago and still are referred to in Boston as carbonated beverages are known in Buffalo, Erie, Cleveland and all points West as "pop"? The attention of the secret service department should be directed to this, the word "pop" has a teutonic sound.

Just before it became dark I saw a hat waving above the crowd, The old dip looked familiar and my opinion was verified a few minutes later when I made out Bill's long nose and bandy legs. We celebrated his arrival with another round of the "ice cold" which Bill recklessly insisted upon paying for.

The mayor thanked the crowd, one and all, for the attention to his few remarks, he hoped he would have the pleasure of addressing them again on the next Fourth of July (great cheering) then announced that the band would play "The Star Spangled Banner," to which he hoped all would lend their voices, after which the pyrotechnic display would take place. Immediately after proclaiming to all the world that this

THE CROWD BEGAN TO GATHER

was the land of the free and the home of the brave, the crowd wildly stampeded for the section of the field which had been roped off. I was quite satisfied to stay where we were but the young ladies insisted on getting down to the firing line. I had received strict orders before leaving home to be "careful of those children and keep out of the crowd" but I decided to take a chance and if anything happened I could blame it on Bill.

He went ahead and by the judicious use of his elbows and yelling of "gangway" every few steps we finally found ourselves up against the ropes. Soon the show was on in full swing and a chorus of "Ohs" and "Ahs" greeted every rocket.

I asked Bill if he had any idea how fire works were made. He said he had seen some fireworks in the foundry on different occasions when a mold blew up or a ladle of iron upset, but that was as far as his knowledge extended. I said it was simply pitiful how little the average man *did* know and he agreed with me. "Why, even in the foundry business," said he, "the condition of affairs is getting worse all the time. In the olden days, when we were young, a man had the opportunity to learn every branch of the trade. If he did not care to take advantage of it, that was his own fault. In these latter and degenerate days the business is so divided and subdivided and specialized that a man only gets an opportunity to learn one operation in the cycle that goes to make a casting. He is only a cog in the foundry gear wheel and if he drops out they can put a plug in his place. The all around foundryman will soon be classed with the dodo and the great auk. There soon won't be no such animal."

"Oh," I said, "I don't know about that, I heard the other day of at least one all around foundryman right here in town."

"I'd like to see him," said Bill, "where is he?"

"Well," said I, "I'll tell you all I know about him and then you can use your own judgment whether you want to go and see him or not. A friend of mine was out along Apahaukee avenue the other day selling foundry supplies. He saw a sign over a small building 'Brass Foundry,' and he attempted to enter. The place was locked but he was a determined kind of bird and besides his salesman's conscience (if there is such a thing) would give him no rest if he passed a foundry without attempting to make a sale. He knocked at the nearest house and a large colored lady came to the door with her sleeves rolled up and her arms wet from the wash tub. My friend bowed politely and asked the lady if she knew the foundry proprietor, or where he lived. She smiled on him expansively and said, 'Ah suah does, why ah owns him, he's ma husban an he lives right heah.' Our hero made known his business and asked if he might have the privilege of seeing him. 'Why, ce't'nly,' said she 'come right in an set down; he is out just now delivering de wash, he will be back in a hour or two and will be right pleased to meet yeh.' What do you think of that for an all around foundryman?"

THIS WAS AFTER JULY THE THIRST

"Sounds good," said Bill, "but I don't believe you. Your argument is irrevelant to the point at issue. When I spoke of an all around foundryman, I did not mean one who was all around the neighborhood. Neither had I reference to one who was all around like a beer barrel or a doughnut or a pint of half-and-half. What I meant was a man who had learned the foundry business thoroughly. The situation in the foundry industry is really becoming serious. So serious in fact that the United States government, through its department of labor, is preparing to take action in the matter. In a preliminary report prepared by the department, it is pointed out that the supply of skilled foundrymen is entirely inadequate to cope with the present volume of business. It regrets that there is no apparent action by foundrymen to teach their employes and predicts a state of chaos when the present generation of foundrymen dies and the generation now growing up is placed in charge."

"You should change your name to Gloomy Gus," I said to him. "There is nothing to be alarmed about. The situation that is causing you and your friend, the department of labor, so much uneasiness is simply a case of times and methods changing. If we are young enough, we change with them and if we are not, we sit on the fence and grumble because things are not done the way they were when we were boys. All the grumbling in the world will not stop the march of events. So long as men have brains and use them either from pure love of achievement or for love of financial gain so long will industrial conditions keep changing. As for the industry withering up and dying for want of competent overseers and operatives after we take our hands off the wheel, I think you may let the undertaker take your measure any time. There were castings made on this old earth, thousands of years before the present generation of foundrymen howled their way into existence, and there is no reason why there should not be castings made after the last one of them has been permanently bedded in a pit six feet by two in the cemetery.

"The day of the all around molder or foundryman has gone by. The tendency in the foundry as in every other business is to divide every operation into its component parts, in order to employ more men and get a larger output than would otherwise be possible. In this way a minimum of individual skill is all that is required on the part of the operatives.

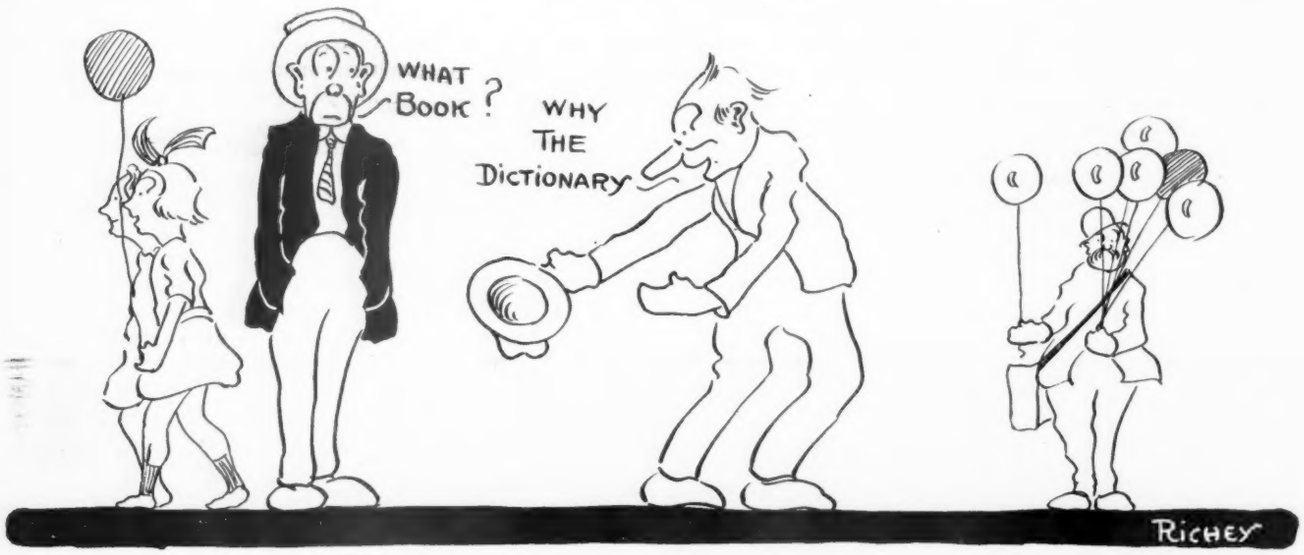
"The men in charge of foundries need to have a general knowledge of foundry operations but not necessarily an intimate knowledge of all the details. The boys who are destined to become foremen and superintendents will find ways and means to get the necessary information. It is not the man who knows the most, who is the most valuable. It is the man who knows how to use what he knows. Grant did not have any reputation as an A-1 all around soldier when Lin-

coln sent for him, but he made a pretty good job of a certain little proposition that was put up to him. Neither Lincoln or Cleveland learned their trade in a modern president factory but you must admit that they were competent journeymen presidents. They had brains, ambition, courage and a sense of justice, and that is a combination that will land a man in the front rank either with or without training, when it is applied."

"Good night," said Bill, "if you are going to drag politics into the thing you can count me out. Besides that peroration of your's is all second-hand stuff, I saw every word of it in a book I have at home."

I indignantly dared him to prove it and asked him what was the title of the book in which he had seen it.

"The dictionary," said he, with a rather sarcastic grin.



How and Why in Brass Founding

By Charles Vickers

Proper Sand for Brass Castings

We operate a small brass foundry and have been advised by one of our customers that we could produce finer brass castings if we used a French sand. We have tried to secure some of this sand but so far without success. Can you advise us where to procure it? Also we would appreciate any advice concernin the best sand to use for fine brass cas...gs.

French sand would be entirely unsuited to the class of castings being made in a small ordinary foundry. This sand is used in making statuary because it can be hammered against a pattern until so compact it will not break or tear when the section is removed. It is not suitable and is too expensive for ordinary molding. If an exceedingly fine grade of sand is desired, Windsor Locks as it is known would be suitable, and it can be obtained from any large foundry supply house. We are of the opinion, though, that satisfactory castings can be made by using ordinary brass molding sand of a fine grade. Most supply houses make a specialty of fine grades of brass sand. Probably the sand now being used is of too coarse a grade and if this is found to be the case on comparing with the fine sand, all the old sand should be thrown aside or be stored and used in coremaking. Do not mix it with the new and finer sand, otherwise the castings will show little improvement.

High Pressure Alloys

We have lately experienced difficulty in getting castings that will not leak under air pressure. We have tried an alloy of copper 90 per cent; phosphor tin 10 per cent. The phosphor tin contained 5 per cent phosphorus, and thus added 0.5 per cent phosphorus to the alloy. Another alloy tried was copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, but both alloys leak at 500 pounds air pressure. We are careful in melting the metals, using plenty of charcoal, and have tried both oil-fired and coke-fired furnaces with the same results. We make the cores with flour as a binder, making them weak, then spray with linseed oil to produce a skin.

The phosphor bronze failed because it contained too much phosphorus, and the 88-10-2 is notoriously a difficult alloy to withstand pressure. If necessary to use one of the two alloys that have been tried, select the first one mentioned, but instead of using all phosphor tin, change the formula to copper 90 per cent; common tin, 8 per cent; phosphor tin, 2 per cent, and if a little lead can be added, about 2 per cent, in place of 2 per cent copper, or even 2 per cent of tin, the alloy will be improved. The following alloy, however, has been very successfully used for castings subjected to air pressures. Copper, 82 per cent; tin, 7.50 per cent; zinc, 5 per cent, and lead, 5.50 per cent. See that the castings are made with extra high heads to give plenty of pressure to the metal and pour with the metal hot.

Bushings of Copper Alloys

We have experienced considerable difficulty in making bushings of an alloy of copper, 80 per cent; tin, 10 per cent, and lead, 10 per cent. We exercise all reasonable care in melting and molding, using charcoal on the metal, and working the sand as dry as possible, but the castings when machined contain blow-

holes. How can we remedy this condition? We also would like to learn where we can obtain reliable information concerning the state of the copper market.

There is a possibility that the porosity of the bushings is due to high sulphur in the fuel used in melting the metal. This will result in a furnace atmosphere strongly impregnated with sulphur dioxide gas, which will be absorbed by the copper if the charcoal covering burns away and exposes the metal to the furnace gases. This gas is also formed in the copper when sulphur and oxygen come into contact, and as the copper takes up both these elements readily, the gas is easily formed in the copper. This is a simple explanation of how the gas is formed; in reality the reactions are probably quite complicated. To prevent the formation of holes, the metal must be protected from the two elements that cause them. This can be done by covering the metal while melting with a tenacious flux, such as a mixture of powdered glass, borax and charcoal. Use about one part borax and charcoal to eight parts powdered glass.

Reliable information concerning the copper market can be obtained daily by subscribing to the *Daily Iron Trade and Metal Market Report,* Penton building, Cleveland, O. The subscription is $10 per year.

Cracking of Aluminum Crank Case Castings

We have experienced difficulty in casting a four-cylinder aluminum crankcase, about 18 by 9 inches in size. The inside of the case is cored out and although we have made the core as soft as possible consistent with sufficient strength for handling, the casting cracked over the core across almost the entire side, although we got the core out as soon as possible after casting. Could you recommend a core mixture suitable for this casting, or would you suggest that a wedge-shaped arbor be placed in the core, and then be withdrawn as quickly as the cope could be removed from the poured mold?

It is seldom that a casting can be released from the sand after being poured in time to permit it to shrink without cracking, because it is necessary to wait until the metal is no longer liquid before the mold can be removed, and with most metals and alloys the contraction has then taken place, and the crack has formed if it is going to form. Aluminum bronze is an exception to this rule and that is why it can be used for die-castings. After solidification there is an appreciable interval before it contracts, and if the die is opened the casting is removed without difficulty, but if this is not done in time the casting will grip the mold firmly and be difficult to eject, and may possibly be broken.

Aluminum is tender as it congeals, but in spite of this complicated cored castings are made continually without cracking. The important thing is not to pour too hot. For a thin casting pour at 1300 degrees Fahr., by pyrometer, and use a core that is more easily burnt than an oil sand core. Such a core is a flour sand core, surface hardened by spraying with molasses water.

Difficulties With Fire-Hose Couplings

We have experienced some difficulty in making fire hose couplings. The work proceeds satisfactorily for a period of months, then we have trouble with excessive breakage, the castings are found to be perfectly sound, but crack under expansion. Our formula consists of copper, 89 per cent; zinc, 5 per cent; lead, 4.5 per cent, and tin, 1.5 per cent. We use no scrap metals outside of our own turnings and gates. We would appreciate advice in regard to this matter.

The difficulty being intermittent would indicate that some impurity occasionally gets into the metal and produces brittleness. If the alloy were a yellow brass, antimony would cause this difficulty when present in fractions of 1 per cent. With the alloy used, however, it is difficult to see how antimony can produce this breakage unless it is present in proportions higher than 1 per cent. The only certain way for discovering what causes the trouble is to have analyses made. Have a normal casting analyzed, then when the castings begin to fail by breakage, have the broken castings analyzed and compare the analysis with that of the normal casting. If antimony is found in the broken casting and not in the other, it will be evident what has caused the difficulty. Whatever it is the analysis will detect it and is the cheapest way of running down the difficulty.

Benedict Nickel or Benedict Metal?

We have an inquiry for an alloy known as "Benedict" metal and we would like to obtain the formula for the same. We have the formula for "Benedict" nickel, but this is not the mixture required. We assume the mixture is similar to the admiralty metal, copper, 70 per cent; tin, 1 per cent; zinc, 29 per cent.

"Benedict" nickel is an alloy of copper and nickel the proportions of which may vary within considerable limits, but usually it is composed of copper, 80 per cent, nickel 20 per cent. It is a rolling mixture and is used for tubing connected with plumbing fixtures, because it is white and maintains a creditable appearance after the nickel plating has worn off. "Benedict" metal is simply another name for "Benedict" nickel, and applies to the same mixture. However, it is possible that locally the name might be applied to any composition, therefore, if it is reasonably certain that a yellow brass is desired, the mixture mentioned could be used. Instead of regular admiralty metal it would be advisable to use some mixture that casts well. If the castings are to be machined, the following mixture would give satisfaction: Copper, 70 per cent; zinc, 25 per cent; tin, 2 per cent, and lead, 3 per cent. It would be advisable to get a sample of this particular "Benedict" metal, and if it has a white color, it is a copper-nickel alloy; if yellow, a copper-zinc alloy, when the above mixture should be used, and if it is gold color, it is a red brass, and any ordinary mixture of red metal such as copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent; lead, 5 per cent, would prove satisfactory.

Properties of Nickel-Copper Alloys

Kindly advise us regarding copper-nickel alloys such as copper 98 per cent, nickel, 2 per cent. We are confused in regard to the proper pouring temperature for these alloys.

According to Hiorns there are no chemical compounds of copper and nickel, neither is there any eutectic mixture, as the two metals form solid solutions or mixed crystals in all proportions. All the alloys with excess of nickel are magnetic, and those with excess of copper are nonmagnetic. Soft drawn alloys of copper 98 per cent, and nickel 2 per cent, have a tensile strength of 32,200 pounds per square inch, and when hard drawn, 53,392 pounds tensile strength. With 5 per cent nickel the tensile strength of soft drawn material is the same as the 2 per cent nickel alloy, and at 25 per cent nickel, the tensile strength is around 60,000 pounds per square inch.

In casting an alloy of copper 98 per cent and nickel 2 per cent, treat it in every respect the same as pure copper as the content of nickel is too small to have any effect from a foundry standpoint. The copper-nickel alloy will require deoxidizing exactly the same as in the case of pure copper, otherwise the castings in sand molds will be spongy. Either silico-calcium copper or magnesium-phosphor copper should be used in deoxidizing copper for shell bands, otherwise its ductility will be low.

Where Converter Castings Are Made

Cupolas Used for Melting the Metal in Converter Steel Foundries Show Remarkable Performance When Compared With the Practice Current in Most Gray Iron Shops

WHEN Henry Bessemer conceived the idea and later put into actual practice the principle of blowing a current of air through a quantity of molten iron thus converting it into steel, it is doubtful if he realized what a tremendous impetus the invention was to give to world trade. The development and importance of the steel industry may be likened to a certain extent to the career of the distinguished inventor.

There are many foundries in this country which make steel castings by the bessemer process exclusively, and of these the Burnside Steel Foundry Co., Chicago, is fairly representative. This company specializes in railway and traction work, but also does a general jobbing business in small and medium sized castings. The plan, Fig. 4, shows the arrangement of the plant and the location of various units that enter into the manufacturing activities. The building covers 31,600 square feet which may be divided into four sections. Reading up and from left to right they are: The molding floor, 180 x 60 feet; sand blast and cleaning room 100 x 20 feet; and the main bay 280 x 40 feet, one end of which is devoted to molding and the other to cleaning the castings. The section of the building shown in the upper part of the plan 280 x 20 feet is occupied by the core ovens, core room, cupolas and converters, the power house, arc welder and annealing ovens. This wing of the building as well as that portion housing the sand blast and tumbling barrels on the opposite side are extensions to the main building. The buildings are of steel frame construction with the roof and ends covered with corrugated sheet steel. The outside wall between the columns is built of brick to a height of four feet. From this elevation to the roof is one continuous window sash extending the entire length of the building. Fig. 3 indicates the excellent lighting and ventilating facilities thus afforded. The columns are 20 feet apart on the center lines, and between each pair are twelve 6-pane sections of windows which are hung on pivots and can be adjusted from the floor. Fig. 3 also shows a section of the shop where the light work is made. A day's supply of cores for one of the jobs which is going through on a production basis is piled in the foreground. This part of the shop, as may be seen from the plan, Fig. 4, is equipped with 11 molding machines of various types and makes. There are six Buch hand jolt and squeeze, one jolt squeeze and pattern draw constructed by The Arcade Mfg. Co., Freeport, Ill., two Osborn jolt and squeeze, and two plain squeezers from the Federal Foundry Supply Co., Cleveland. In addition to these there are two heavy-duty jolt roll-over pattern draw machines in the main bay, built by the Cleveland-Osborn Mfg. Co., Cleveland.

Nearly all the work is light and is poured in green sand. Some of the molds made in the bay devoted to heavy work are poured green and some of them are skin dried. It depends more on the shape of the casting than on the weight, whether the mold is to be dried or not.

Fig. 2 illustrates the machine on which grousers are made for caterpillar tractors. It is Buch combination hand jolt roll-over pattern draw which takes both cope and drag at one time. In the illustration the cope and drag are ready to be taken away from the machine and set on the floor. After they are lifted, the platforms on which they are resting will be swung in under, to receive the pattern boards. An ingenious roll-over clamping device is in use on this machine. When the cope and drag are rammed and the bottom boards in place the bar *A*, Fig. 2, is laid across with the pads *CC* resting one on each bottom board. The clamp *B* is then swung upright, the gap in the clamp engaging the bar *A*. The ends of the bar instead of being round, are eccentric; therefore by a turn of the handle *D* the bar is locked. The end of the clamp bolt is threaded and therefore it may be adjusted to fit flasks of different heights. The pattern and flask repair shop is located in a closed balcony at one end of the light work bay. In

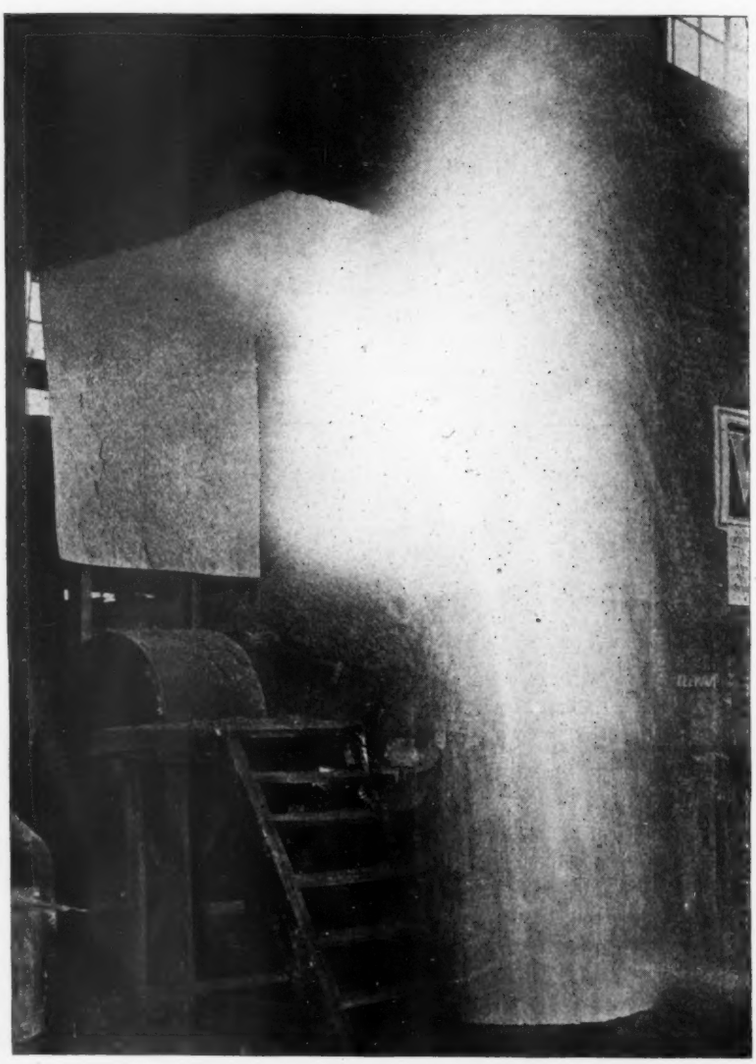


FIG. 1—NEARLY READY TO TIP AND POUR—THE BESSEMER CONVERTER IN ACTION

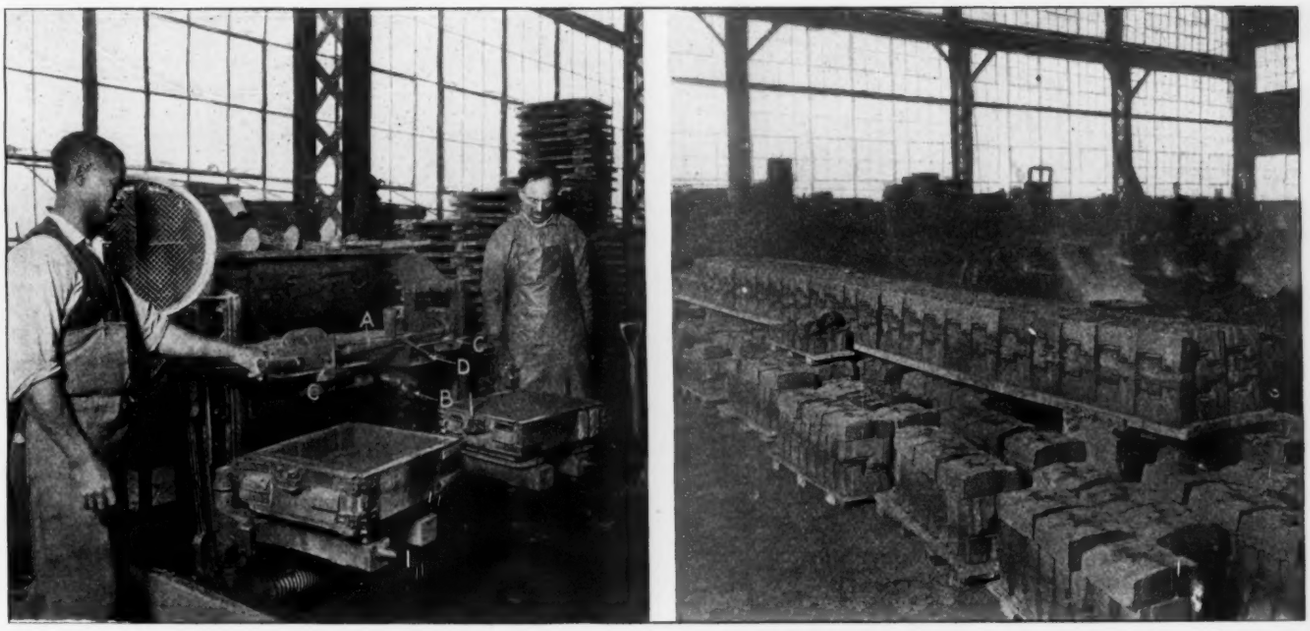


FIG. 2—ONE OF THE MACHINES ON WHICH THE GROUSER MOLDS ARE MADE—NOTE THE CLAMPING BAR A FOR HOLDING COPE AND DRAG WHILE TURNING. FIG. 3—A DAY'S SUPPLY OF CORES FOR TWO MACHINES

addition to the equipment of an ordinary pattern shop a miniature aluminum and brass foundry is provided in which to make or repair metal patterns. The quantity of metal used at any one time, of course, is not large and is melted in a small open gas-fired furnace.

One-third of the main bay is devoted to medium sized and heavy work, and is served by a 7½-ton Northern crane. Here also is located a 6-foot Simpson grinding pan for mixing the facing sand for the molders and two jolt roll-over draw machines made by the Cleveland-Osborn Mfg. Co., Cleveland. These are utilized when there is a large number of molds to make from one pattern. Most of the work made on this floor consists of miscellaneous parts with only one or two molds of a kind. Some of the castings in this bay are poured in green sand, but most of the molds are skin dried. Gas torches are used extensively for this purpose, although in some instances charcoal is found to be more convenient. Frequently both methods are used on the same mold; the gas torch on the drag and the charcoal fire under the cope.

The method of handling molten steel is illustrated in Fig. 5. The tap ladle is taken from the converter by the crane and set on the pouring stand shown. From this stand metal is distributed all over the shop in bull ladles. This applies only to the light work. The heavy castings, of course, are poured direct from the crane ladle. Unless otherwise specified the heavy castings are poured last from each heat. This is to secure a higher carbon content in the heavy than the light castings. In the converter the carbon is blown down to 0.18 per cent or 0.20 per cent or even lower for some classes of work. It is poured from the vessel into the ladle and a certain amount taken to pour the light castings. After a given amount has been taken out it becomes necessary to raise the carbon to a point suitable for the heavier castings. For this purpose a

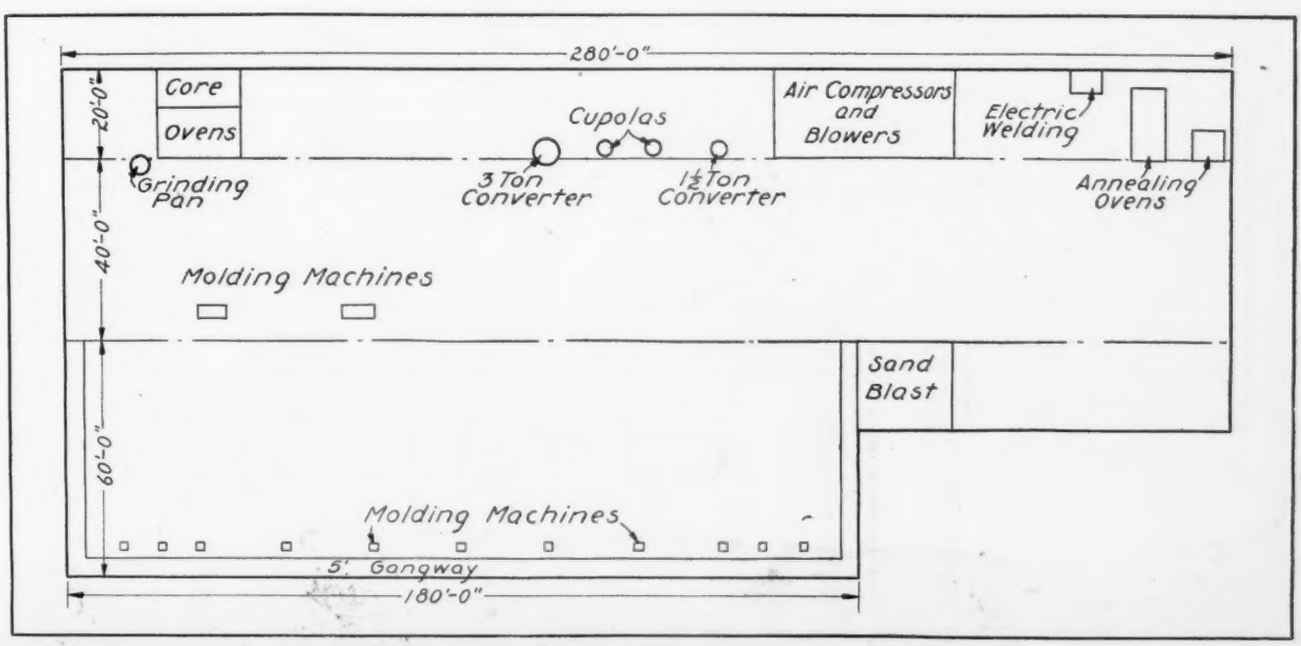


FIG. 4—PLAN OF THE FOUNDRY SHOWING THE LOCATION OF MOLDING MACHINES, CORE ROOM, MELTING UNITS, POWER HOUSE AND ANNEALING OVENS

FIG. 5—THE STEEL MAKING INSTALLATION—THE 28-INCH FURNACE SUPPLIES IRON FOR THE 1½-TON CONVERTER AND THE 42-INCH CUPOLA SERVES THE 3-TON VESSEL

ladle of iron is brought direct from the cupola and enough of iron transferred to the ladle of steel to bring the carbon to the desired point.

The converter at the left, in Fig. 5, blows a 2600-pound charge in about 15 minutes. When the color of the flame indicates that the proper carbon content has been reached, blowing is stopped and the steel poured into the ladle. Here the ferrosilicon and ferromanganese are added to bring it to the desired analysis. The converters are equipped with direct connected electrically operated tilting machinery. There are two cupolas and two converters in this shop, each pair constitutes a complete steel melting unit in itself. At the time the photograph was taken only the smaller one was in commission. The large converter is served by a 42-inch cupola and has a rated capacity of 6000 pounds. The smaller one is served by a 28-inch cupola and blows 2609 pounds each heat. At an average of three heats an hour that means that the 28-inch cupola has to supply nearly 8000 pounds of iron every hour for 6 or 7 hours a day; and not only for one day but for every day in the week. Iron foundrymen who have trouble with their furnaces could derive a great deal of profit by taking a leaf out of this steel foundryman's book. In fact a performance that would be regarded as remarkable in most iron foundries is here treated as a matter of course. Getting 20 tons of iron out of a 28-inch furnace in 6 or 7 hours is looked upon as an ordinary part of the days work.

In the illustration, Fig. 5, it will be noted that the windbox is considerably higher than is usual in furnaces of this size. The slag hole is 15 inches above the sand bed, which means that the furnace holds approximately 1800 pounds of iron before each tap, and therefore two taps will form a charge for the converter. The size of the furnace and the speed of the melting in an installation of this kind depends altogether on the ability of the converter to take care of the metal. The furnace charge consists of 60 per cent steel scrap in the form of shop scrap, draw-bar knuckles and coil springs. To this is added 40 per cent low phosphor pig iron. The

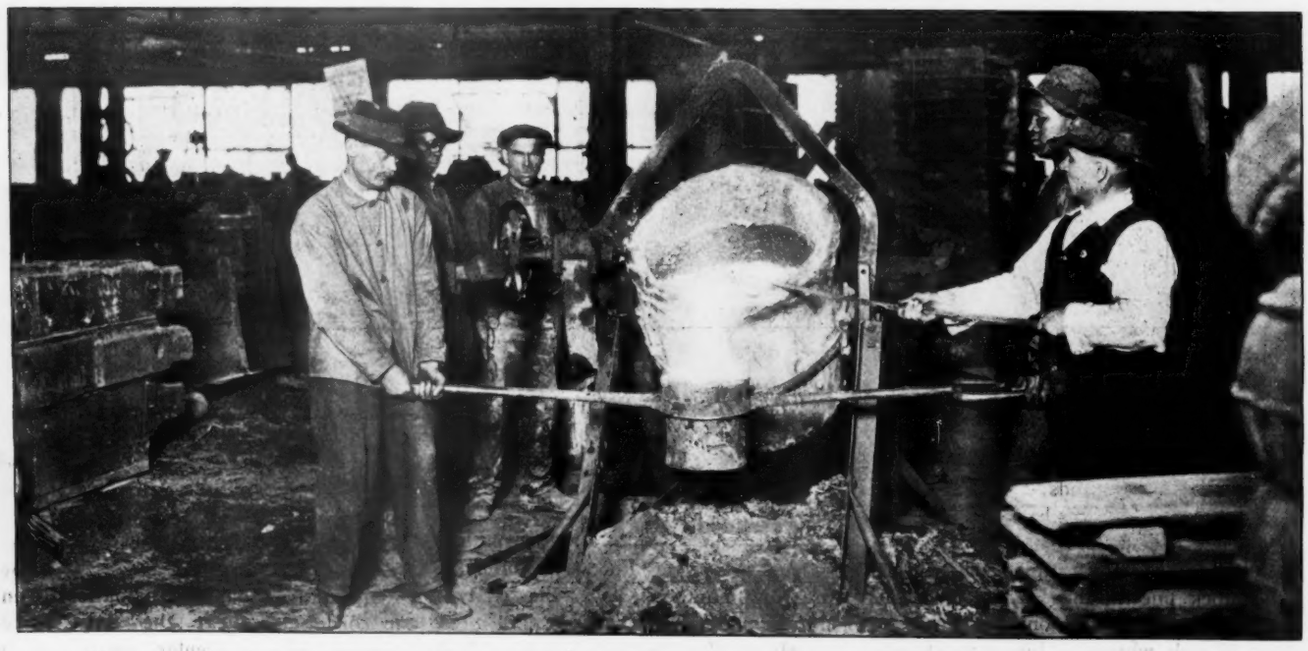


FIG. 6—OWING TO ITS EXTREME FLUIDITY ALL THE METAL IS POURED OVER THE LIP OF THE LADLE

charges are comparatively light, 500 pounds constituting a standard heat. On account of the high percentage of steel in the charge and of the high temperature required, the ratio of coke to iron averages about 5 or 6, to 1. A shovelful of limestone is thrown on each charge for flux. A blast pressure of 10 ounces is maintained throughout the heat and is supplied by a positive pressure blower. The ladles of iron are taken from the furnace to the converter by the crane. After the metal is blown the cranes again take it away. The analysis of the steel for most of the work is 0.18 per cent carbon, 0.30 per cent silicon, 0.08 per cent sulphur, 0.05 per cent phosphorus and 0.65 per cent manganese. The carbon is sometimes raised to as high as 0.80 per cent for large work and for special castings.

The cupola charging floor is served by a hydroair elevator. Adjacent to the elevator there is a cylindrical tank 4 feet in length by 20 inches in diameter which is kept filled with water in summer and oil in winter. From this tank one pipe leads to the elevator cylinder and another to the air supply line. By opening one valve the oil or water, as the case may be, is forced into the cylinder causing the platform or cage to rise. By opening the release valve the air escapes, the platform descends by gravity and forces the oil or water back into the tank again.

The pig iron and scrap are taken from the stock pile to the furnace on iron-frame barrows, each one mounted on two 18-inch wheels. This style of barrow is a comfortable height for loading and unloading. It also is capable of transporting about twice the load possible with the type of barrow having one wheel. A spur track runs alongside the building and all the raw material, iron, coke, limestone, sand, etc., is unloaded and piled close to the building.

The powerhouse is partitioned off from the rest of the building. The equipment consists of two angle-compound air compressors manufactured by the Sullivan Machinery Co., Chicago. These have a rated capacity of 450 and 1100 cubic feet of air a minute, respectively. The blowers for the two converters and for the 28-inch cupola were built by the P. H. & F. M. Roots Co., Connersville, Ind. The blower for the 42-inch cupola is a General Electric centrifugal blowing unit. The cupolas operate on a 10 or 12-ounce blast, but the converters require from 2½ to 4-pound pressure.

The facilities for cleaning the castings are quite ample. They include a sand blast room 10 x 12 feet, manufactured by the Pangborn Corp., Hagerstown, Md.; one combined tumbling barrel and sand blast made by the Whiting Foundry & Equipment Co., Harvey, Ill., and two tumbling barrels from the W. W. Sly Mfg. Co., Cleveland. There is also a Milwaukee power sprue cutter and a 600 ampere electric arc welder.

There are two annealing ovens built by the American Foundry Equipment Co., New York; one is of the car type. In the other the castings are piled directly on the floor of the oven. Both of the ovens are heated by gas. In the large oven the gas enters through three ports in one of the side walls immediately under the roof, and is deflected downward. In the small oven the combustion chamber is under the floor. In both cases the castings are gradually brought to a temperature of 1600 degrees Fahr. This temperature is maintained for two or three hours depending on the size and general characteristics of the castings undergoing treatment. It is then allowed to drop. When the temperature reaches 1000 degrees Fahr. the castings may be taken out, but they are generally left until they are cold enough to handle.

The core room occupies the space along one side extending from the large converter to the end of the building. Oil sand cores are used throughout. The sand for them is mixed by hand and then passed through a Combes gyratory riddle. Fig. 7 shows the core benches and stands for holding the green cores. When commencing work each man places six plates on his stand. He fills the top plate with cores and carries it to the oven and keeps repeating the operation until all the plates are used. He then gets a fresh supply of plates. The cores are dried in three gas-fired ovens. Two of the ovens are of the drawer type, since nearly all the cores are small. There is, however, a large oven with a car in which to dry the large cores. This oven is run at slightly higher temperature than the smaller ovens in order to heat the large cores through to the center more quickly.

FIG. 7—THE CORE ROOM—A STAND AT EACH COREMAKER'S BENCH SERVES TO HOLD HIS PLATES

THE FOUNDRY

A semimonthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.....Prince's Chambers
BOSTON.....426 Old South Bldg.
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SUBSCRIPTION

United States and Mexico.....$2.00 a year
Canada.....$3.00 a year
Great Britain and other Foreign Countries.....$4.00 a year
Single Copies.....15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising, copy, discontinuances, etc., must be received on the 1st and 15th of the month preceding date of publication.

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Systems Change With the Times

EVENTS have moved rapidly during the past decade. There is not such a sharp line of demarcation between the shop and the office as there once was. In one way the recent war has been a blessing. It has dragged out of their hiding places and off their pedestals many a hoary fetish and belief; it has turned the light of ridicule on many a selfish proposition and punched full of holes the armor of conceit in which some long established practices were wont to take refuge. The foundryman who keeps abreast of the times know and recognizes these facts and adapts himself to meet them. He cheerfully scraps tools and processes when they become obsolete and just as cheerfully he scraps systems of management which might have been perfect in his father's time but which he knows are not in harmony with existing conditions. The spirit of co-operation and the square deal are spreading.

Light on Nonferrous Metallurgy

DURING the war a prominent foundry in the Middle West was asked to make eight hundred aluminum crankcase castings for airplane engines. The patterns were fitted up carefully and eight hundred molds were poured, but only three hundred and eighty good castings resulted. Experiences like this are not uncommon in nonferrous shops, specially when dealing with alloys of aluminum. Stories are current to the effect that certain foundries hold their average losses to less than 10 per cent but they are mostly myths. As a matter of fact aluminum is a difficult metal to handle and while losses do not usually exceed 50 per cent, as in the instance cited, they are prone to be heavy even under the most satisfactory conditions.

The situation, however, is creating its own remedy. Scientific research in the metallurgy of aluminum alloys is being stimulated on a large scale. In addition to the splendidly equipped and ably manned laboratories maintained by producers of aluminum products, such as that of the Aluminum Castings Co. described in our June 15 issue, the government is taking up the problem through the bureau of mines. Some of the first fruits of this effort are made available in this issue in an article on "Unsoundness in Aluminum Castings," by Robert J. Anderson. Mr. Anderson believes that porosity is one of the chief difficulties that must be overcome in connection with the development of satisfactory aluminum foundry conditions. His experiments indicate that porosity is a function of the pouring temperature, the maximum temperature to which the charge was heated in the furnace, and the length of time required to melt the charge. Mr. Anderson's conclusions are tentative but they point the way to an interesting and profitable field of investigation, which, it is to be hoped, will be more thoroughly explored.

As Mr. Anderson says, porosity is no myth, and his statement is corroborated by the figures on aluminum foundry losses presented in our July 1 issue. One of the most encouraging features of the government's investigation of this problem lies in the fact that the results of its work are public. There has been too much mystery in the past regarding nonferrous metallurgy. An atmosphere of alchemy is not conducive to progress.

Trade Outlook in the Foundry Industry

THE tide of orders for castings continues to rise and the books of some gray-iron foundries are overflowing. Prices of both raw materials and castings are less sensitive to small fluctuations in demand than was the case a few months ago. This relative stabilization of the price situation, even though it be temporary, is a business factor of considerable importance. Generally speaking, the world's production of commodities is increasing as a result of the tendency to restore normal conditions, and after the first rush of post war demand is over, a gradual price liquidation must follow.

Orders Going East

Automobile and tractor manufacturers in the Middle West have exhausted the capacity of the foundries in their immediate district, and as a result inquiries for large quantities of gray-iron cylinder and other motor car castings are finding their way east. This is one of the most notable developments in the casting market. One inquiry now pending in the east calls for numerous different kinds of castings, and the number of castings in each classification ranges from 15,000 to 20,000. Another inquiry almost as large is also current. It is not known whether any eastern casting shops are considering these inquiries seriously, since the booking of the orders would necessitate considerable floor space and the purchase of a large amount of additional equipment. Additional labor also would be required. It is stated, however, that if this business is placed in the east, it will remain there permanently, the buyers agreeing to place orders regularly in the future with eastern foundries. It is not unlikely, therefore, that a few eastern plants may be prevailed upon to provide the necessary equipment to handle this work. Although the gray-iron foundry business is exceedingly good in all sections of the country, it is probably showing more activity in the east than elsewhere and in addition to the automobile work just mentioned, numerous other orders are in sight. A great improvement in conditions is reported by producers in Newark and other northern New Jersey districts. The foundries in that territory have as much work as they can handle. While prices on castings in the Newark district have not changed materially in the past two weeks, they continue strong and there is no longer any disposition to cut quotations. In metropolitan New York where unsatisfactory conditions have been noted previously, considerable improvement has taken place. Foundries in this territory devoted to the production of ornamental iron work, which have been running very slack, now say that orders for castings are beginning to appear in greater volume. As a result these foundries also are less eager to cut prices, although some shading still is being done. In the Cleveland and other central western districts, the volume of inquiries for iron castings shows no abatement and similar conditions are noted in Mississippi valley territory. Prices are firm throughout the country.

Prices Of Raw Materials for Foundry Use

CORRECTED TO AUG. 21

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Val'ey	$21.00 to 21.50
No. 2 Southern, Birmingham	27.50	Heavy melting steel, Pittsburgh	21.00 to 21.50
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	20.00 to 20 50
No. 2 Foundry, Philadelphia	28.50 to 29 50	Stove plate, Chicago	25.00 to 25.50
Basic, Valley	25.75	No. 1 cast, Chicago	27.50 to 28.00
Mal'eable, Chicago	27.25	No. 1 cast, Philadelphia	25.00 to 26.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	24.00 to 25.00
		Car wheels, iron, Pittsburgh	25.00 to 25.50
Coke		Car whee's, iron, Chicago	24 50 to 25.00
Connellsville foundry coke	5.50 to 6.50	Railroad malleable, Chicago	23.50 to 24 00
Wise county foundry coke	6.50 to 7.50	Agricultural malleable, Chicago	21.50 to 22.50

Labor is Scarce

One of the principal problems occupying the attention of foundrymen in various sections of the country is the shortage of workers of all kinds, particularly unskilled labor. For five years there has been practically no immigration and since the first of the year emigration has been considerable. The effect of this situation is becoming more and more pronounced in the unskilled labor market as time goes on. Because of the shortage of unskilled labor and handymen suitable for operating machines, it is difficult to maintain operations, even where the foundries have plenty of work on their books. Of course, these conditions add to the instability of the labor situation. Wages, however, are fairly steady for the time being and in districts where union shops are operated it is not expected there will be any change in current rates until existing agreements expire. Along the eastern seaboard the number of men applying for work is very small and the usual floating supply of molders and common laborers is almost nonexistent.

Raw Material Markets

The rush for pig iron which has been in evidence during the past month, has subsided to some extent, although the demand for all grades suitable for casting purposes, continues heavy. Most producers are booked up for the remainder of the year. It is now believed in the Middle West that some shortage may be felt later in the year as inquiry is still active in the Chicago territory and many melters apparently have not covered. Prices are about $1 a ton higher in the south. Scrap quotations, however, are generally low owing to larger offerings from country sources. The coke market has experienced a radical change in the past two weeks and instead of being in the buyer's favor, it is now tending strongly toward prices in effect during the period of government control. The transition of the coke market from a condition of weakness to one of strength may be ascribed to the fact that fear of a shortage later in the year has prompted considerable buying for stock. Buying of nonferrous metals is on a comparatively small scale. The shortage of labor has curtailed the production of copper, zinc and lead. Prices of nonferrous metals are moving within relatively narrow limits. New York quotations are as follows: Casting copper, 22.50c; lead, 5.90c to 6c; tin, 56c; antimony, 8,75c; aluminum, No. 12 alloy, 28c.

Comings and Goings of Foundrymen

EUGENE F. BALL, who was re-elected president of the National Association of Pattern Manufacturers at its second annual convention, held at the Hotel Statler, Buffalo, Aug. 16-17, is general manager of the Newark Stamping & Foundry Co., Newark, O. Mr. Ball enters his third term as president, having held that office in the original organization, known as the Inter-State Association of Pattern Manufacturers, which became the National association in 1918. It was at the suggestion of Mr. Ball and E. O. Melvin of Columbus, O., that an organization of this character was started and proof of its popularity is found in the fact that in the past year its membership has grown from 28 to over 200.

L. G. Williams, East View Farm, R. 6, Box 50, Hopkinsville, Ky., is organizing a company to build a plant in Oklahoma for the manufacture of farm and mining machinery. A small foundry equipped with modern devices, an up-to-date brass foundry, machine, blacksmith's and forge shops, equipped with labor-saving appliances and automatic machinery, and a pattern shop with modern wood-working equipment all are contemplated.

W. L. Shaughnessy and J. P. Carney of the William L. Shaughnessy Co., Gardner, Mass., manufacturer of casket hardware, recently purchased the foundry, operated by Lord, Stone & Co., Otter River, Mass. They will form a new company, incorporated at $50,000, to be known as the Otter River Foundry Co. They will continue the manufacture of stoves, which the foundry has been producing for a number of years.

F. J. McGrail, who has had charge of the foundries of the Honolulu Iron Works Co., Honolulu, Hawaii, for some time, formerly was with the Henry R. Worthington Pump Co., Harrison, N. J., and for eight years was foundry superintendent of the Struthers-Wells Co., Warren, Pa., resigning that position to locate in Honolulu last May.

Edward Shearson of Shearson, Hammill & Co., New York, resigned recently as director of the American Steel Foundries.

J. F. Blank, who recently resigned from the bureau of mines, where he was doing experimental work in connection with the extraction of helium from natural gas for use in balloons, now is identified with the Wilson Foundry & Machine Co., Pontiac, Mich., doing foundry efficiency work and assisting the foundry engineer in foundry methods. Mr. Blank enlisted in the chemical warfare service division in September, 1917, and was discharged as a lieutenant in January, 1918, when he accepted the position in the bureau of mines. Prior to his enlistment, he was connected with the methods department of the Western Electric Co., Hawthorne station, Chicago, having charge of the methods and efficiency work in its foundries.

George N. Peek, formerly vice chairman of the war industries board and

EUGENE F. BALL

former vice president of Deere & Co., Moline, Ill., has been elected president and general manager of the Moline Plow Co., to fill the vacancy caused by the retirement of Frank G. Allen, who was its head for many years.

C. Bateman Swasey was recently elected treasurer of the Belcher Malleable Iron Co., Easton, Mass. Formerly Mr. Swasey was superintendent of the Gorham Mfg. Co.'s Allen avenue plant, Providence, R. I.

Lieut. Clifford L. Snyder, who recently was discharged from the army, has become affiliated with the technical staff of the Detroit Testing Laboratory as sales engineer. Lieutenant Snyder received his commission at Fort Sheridan, Illinois, and later was transferred to the nitrate division in charge of construction work at plant No. 1, Sheffield, Ala.

H. C. Southgate, formerly local treasurer of the Chicago works of the National Malleable Castings Co., Cleveland, who has been absent from the organization for the past seven years, has returned to the Chicago works as assistant local treasurer.

Andrew K. Barr has been made foundry superintendent at the Wakefield, Mass., branch of the Gibby Foundry Co., Boston. He formerly was foreman patternmaker with Davis & Furber Machine Co., North Andover, Mass., since January, 1913.

M. W. McClane was elected president of the Aetna Foundry & Machine Co., Warren, O., at a recent annual meeting of stockholders. Mr. McClane, W. M. McKee, G. P. Gillmer, V. E. Rehr were elected directors. Mr. Rehr was also elected vice president; G. P. Gillmer, treasurer, and M. C. Boyd, secretary.

Judge Will Cummings was elected president of the Southern Foundry & Machine Co., Chattanooga, Tenn., at its recent organization. E. D. Herron was elected vice president and general manager.

Albert A. Smith of Albert Smith & Co., Glasgow, Scotland, foundry engineers and machinery merchants, has arrived in the United States to visit American manufacturers of labor-saving machinery suitable for use in foundries and patternshops, for which, he says, there is a large market in Great Britain.

J. H. Hogue, formerly affiliated with the Great Western Mfg. Co., Leavenworth, Kans., assumed his duties as foundry superintendent for the French Oil Mill Machinery Co., Piqua, O., on Sept. 1.

E. W. Wallbank has been made superintendent for the Parkersburg Rig & Reel Co., Parkersburg, W. Va. He formerly was tool designer with the Savage Arms Corp., Sharon, Pa., and prior to that time was foreman machinist with the New York Yacht & Engine Co., New York City; foreman patternmaker with the Producers' Supply Co., Franklin, Pa.; and tool designer with the General Electric Co., Erie, Pa. He also has contributed various articles on patternmaking and molding methods to THE FOUNDRY.

Carl F. Dietz was appointed vice president and general sales manager of the Norton Co., Worcester, Mass., in the reorganization which followed the com-

bining of the Norton Co. and the Norton Grinding Co., noted in the Aug. 1 issue. W. LaCoste Neilson was appointed vice president and foreign manager; Herbert Duckworth and Howard W. Dunbar, sales managers of the grinding wheel and grinding machine divisions, respectively; John C. Spence and Charles H. Norton, superintendent and chief engineer, respectively of the grinding machine division.

J. L. Dixon, formerly connected with the John A. Crowley Co., now is associated with the T. W. Price Engineering Co., Woolworth building, New York, as metallurgist and electric furnace engineer. Mr. Dixon has had a wide experience in the design, installation and operation of electric furnaces for foundries covering a period of over 11 years. The T. W. Price Engineering Co. will continue the construction and installation of electric furnaces.

James Savage, formerly of Brooklyn, N. Y., now is foundry superintendent for the Atkinson Co., Rochester, N. Y., successor to Clum & Atkinson.

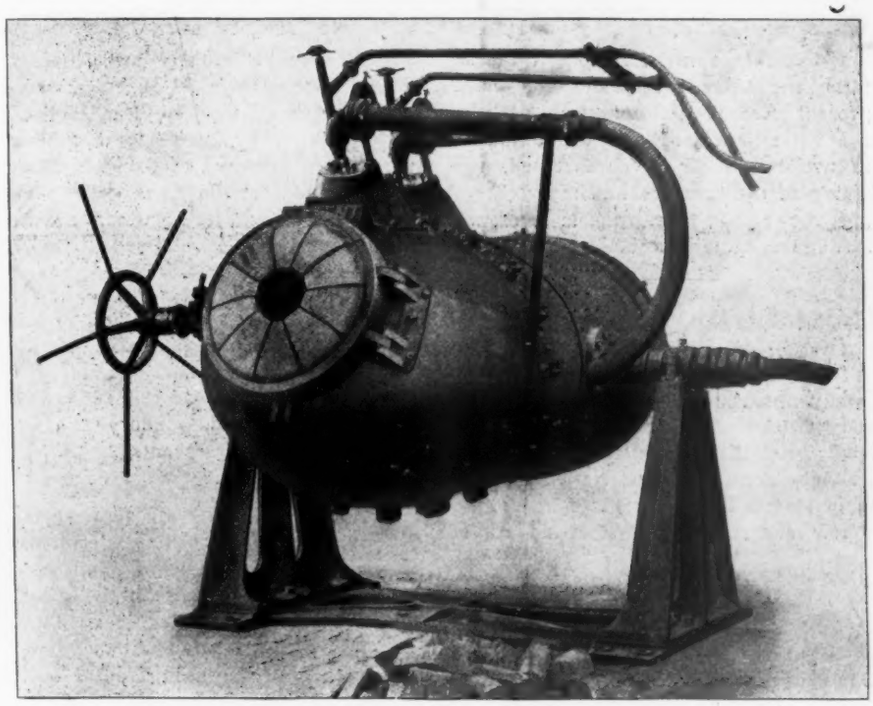
W. T. Howell, formerly with the Stewart-Warner Speedometer Corp., Beloit, Wis., has been made superintendent of the foundries operated by the Emerson-Brantingham Implement Co., Rockford, Ill.

A. Bigelow, formerly with the Metz Automobile Co., Waltham, Mass., has been made superintendent of the brass and aluminum foundry of the Rider-Bagg Co., Springfield, Mass.

The Philadelphia local committee of the American Foundrymen's association has issued an artistic multicolored poster announcing the annual convention and exhibition of the association to be held in Philadelphia Sept. 29-Oct. 3. The Liberty bell adorns the head of the poster. On one side of it is a locomotive and on the other side is a ship under construction, typifying two industries in which Philadelphia holds a prominent position.

New Oil-Fired Tilting Furnace Developed

A new type of oil-fired melting furnace has been developed by the Monometer Mfg. Co., Ltd., Birmingham, Eng. This furnace, which is shown in the accompanying illustration, was designed by Isaiah Hall, an English inventor and metallurgist, who is managing director of the company. The melting chamber is elliptical, and is mounted upon trunnions so that it may be rotated horizontally by gears actuated by a hand wheel. The burners are placed at the top as shown, and flexible hose connections to the feed lines permit freedom of movement in tilting. The internal measurement of the type shown is 2 x 3 x 6 feet, a size, which it is said, will melt from 1800 to 3000 pounds of metal to the charge. The cap bearings may be removed, the fuel and air line couplings disconnected and the entire furnace may be picked up by a crane and carried to any part of the foundry for pouring direct into the mold, if desired. This removable feature permits a spare melting chamber to be provided, to be used while another is being relined, thus avoiding interruption.



OIL-FIRED MELTING FURNACE

The proportion and pressure of both air and oil may be regulated independently to suit the conditions required. Temperatures in excess of 1800 degrees Cent. may be obtained, and it is said that the burners are so directed that a blanket flame is secured over the entire surface of the bath. The oil supply is delivered under gravity pressure, and an air pressure of from 2 to 5 pounds is required. Air pressure is controlled by hand valves at each burner. The flame may be cut off temporarily to allow inspection of the charge within. This inspection is further facilitated by the circular door at the front of the furnace, through which the products of combustion escape when the flame is on.

It is stated that this furnace may be used economically in the gray-iron plant as an accessory melting medium with the cupola, in steel foundries for melting alloys, and in nonferrous foundries for general melting purposes. The fuel cost per unit is a variable factor, depending upon the heat which it is necessary to develop with the different metals. It is stated that the lining is durable. The time required to melt a charge of pig iron is given from 45 minutes to an hour. An output of six tons per day of 10 hours is possible at this rate of melting.

This furnace is the latest product of the Monometer Mfg. Co., Ltd., which specializes in crucible and non-crucible melting furnaces, both of the tilting and stationary type, de-tinning, wire-tinning, cable-covering, and die-casting machines. The company anticipates the establishment of an American manufacturing branch to manufacture its line of products.

Captain Teixeira, a member of the Brazilian military commission, who recently spent several months in this country investigating steel plant and electric furnaces particularly, has placed an order through Fenwick Freres & Co., New York, for a Greaves-Etchells electric furnace, manufactured by the Electric Furnace Construction Co., Finance building, Philadelphia.

The Norton Co., Worcester, Mass., has established a store at 73 West Congress street, Detroit, to handle grinding wheels and abrasive products used extensively in automobile manufacture. The store and service department of the new branch will be managed by C. W. Jinnette, who has been Detroit representative of the company for a number of years.

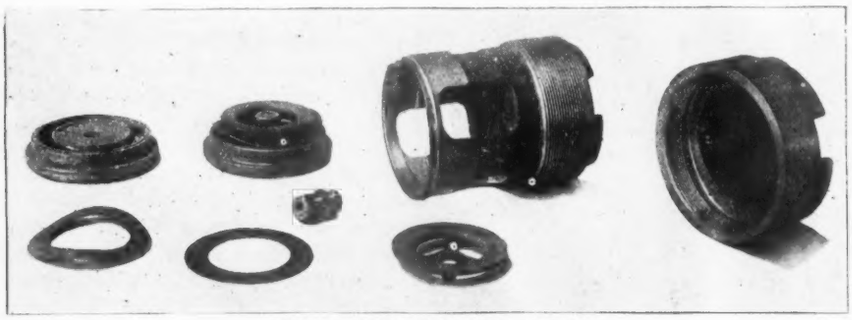
New Wafer Compressor Valves

The Sullivan Machinery Co., Chicago, is embodying a wafer air compressor valve as an improvement on several of its single-stage steam and belt driven compressors. The small size, light weight and compactness of the valve and its spring and seat are shown in the illustration below.

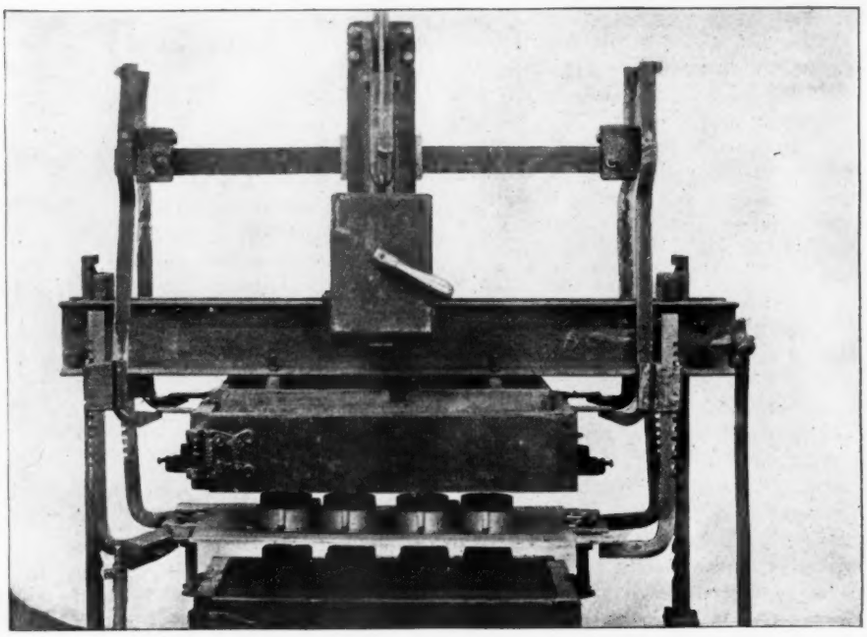
The wafer valves seat in cages arranged radialy to the axis, and close to the two ends of the cylinder, the inlet valve being at the bottom and the discharge valve at the top. The valves are held to their seats by flat annular steel springs; they open against specially designed guard plates intended to give a wide port opening with a minimum of clearance volume. The valve, spring and guard are accessible by removal of a screw plug.

The short and simple construction of the springs permits the valves to be located quite close to the bore of the cylinder. The question of repair stock is simplified because the same valves, springs and guards are used for both inlet and discharge.

Compressors equipped with these valves are unloaded in the same manner as those having automatic poppet valves. There is an air pipe connection from the receiver which is controlled by a pilot valve at the side of the air cylinder. When the receiver pressure rises to the unloading limit the pilot valve admits air pressure through branch pipes to small plunger pistons located in the valve plugs. The other end of the piston carries a three-pronged extension which raises the inlet valve from its seat until the receiver pressure falls the required amount, thereupon the plunger piston falls, the valve seats, and the compressor resumes its operation. While the valve is raised and the unloader in action, no air is compressed, the piston of the compressor simply carrying the air at atmospheric pressure through the cylinder and open valves.



WAFER COMPRESSOR VALVE PARTS



MOLDING MACHINE OF PLUNGER TYPE EQUIPPED WITH COPE-HANDLING AND PATTERN-DRAWING DEVICE, SHOWING MOLD OPENED AND PATTERN READY FOR REMOVAL

Cope Lifting and Pattern Drawing Attachment

An improved form of cope handling and pattern drawing attachment has been placed on the market by the Foundry Appliance Co., Newark, N. J. It is stated it may be attached with a few set screws and the aid of a monkey wrench to any air squeezer of the plunger type. Conceived originally for handling deep, heavy copes, the application of the device has been extended to all sizes of flasks, including molds of the flat-back type. The cope is lifted and the pattern drawn mechanically. It is claimed that by its use production has been increased from 33 1-3 to 100 per cent, this increase being due to the elimination of all unnecessary labor. Furthermore it is claimed that its employment not only dispenses with 50 per cent of the labor but removes the necessity for molding skill on the part of the machine operator.

The device consists of two parts. The upper portion which performs the functions of cope lifting and pattern drawing, is mounted on the cross rail of the molding machine. Two vertical arms, one on either side, are suspended from a horizontal bar. This bar is in turn suspended from a counterweighted cable which passes over a sheave. Each of the arms is provided with two sets of lugs which intercept respectively, the cope and pattern plate as the plunger of the machine is lowered after the mold has been rammed. The arms are mounted on scale point bearings. This feature, in conjunction with the suspension of the entire upper portion of the device from a single cable, insures the proper alignment of the cope and pattern, irrespective of the position in which the mold is rammed. The use of scale point bearings also insures compensation for any irregularity on the flask.

The distance between the vertical arms may be increased or decreased

to allow for any size of flask, and the elevations of the lugs may be adjusted at will. The vertical motion of the upper part of the device is governed by the position of the counterweight. This is set upon a slight incline and may be moved up and down by the molder as required.

The second of the two principal parts of the device is a movable table which is clamped to the molding machine table proper. It is mounted on rollers, making it possible to pull the drag forward in order to set cores after the mold has been opened.

Book Review

Abrasives and Abrasive Wheels, by Fred B. Jacobs; cloth, 340 pages, 5 x 8 inches; published by the Norman W. Henley Publishing Co., New York, and furnished by THE FOUNDRY for $3.

Abrasives and Abrasive Wheels contains valuable information for the ship or foundry superintendent and for the man who is engaged in the operation of grinding machinery of any kind.

The forepart of the book is devoted to natural and artificial abrasive materials such as emery, corundum, garnet, quartz, etc. Under the heading of artificial abrasives, the manufacture of carborundum and other well known manufactured abrasives is fully explained. The chapter on the manufacture of grinding wheels describes the lengthy process through which the material progresses until it is ready for shipment.

The testing of grinding wheels for efficiency is fully explained and illustrated by examples taken from actual working conditions. It is pointed out that by getting the right wheel in the right place, the manufacturer who is a large consumer can save thousands of dollars annually. In one chapter it is claimed that large wheels are more economical than small ones. The author has analyzed several popular sized wheels from a standard wheel list, determining the cubical contents and cost per cubic inch. It is shown that as the size increases the price decreases.

The subject of grinding wheel grits and grades, generally a confusing one to the average layman, is made plain. It is pointed out that grinding wheel manufacturers have never adopted a standard grade list and that such a procedure would save much confusion. With a view of hastening the adoption of a standard list, the author has included a table of standard grades of well known wheels, accurately compared. He explains how this list was prepared and comments upon its accuracy. A proposed standard grade scale is included in the chapter.

Other subjects treated include safeguarding grinding wheels, information for ordering grinding wheels, the design of dust collecting systems, etc. The latter part of the book is devoted to cylindrical, internal and surface grinding, cutter sharpening, etc. Several special grinding operations are fully described.

According to the researches of Leon Guillet and Victor Bernard of France, undertaken with a view of ascertaining if alloys having zinc as a base could be substituted for commercial copper base alloys such as brass and composition metal, an alloy containing zinc, 98 per cent, and aluminum, 2 per cent, appeared promising, but a better alloy is one containing zinc, 88 per cent; copper, 4 per cent, and aluminum, 8 per cent. These alloys were studied to ascertain their hardness, forging temperatures and resistance to shock.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

A small addition will be erected by the Sacks Foundry, Newark, N. J.

A plant is being erected by the Marion Foundry Corp., Marion, Ind.

C. Billups & Sons Co., Norfolk, Va., has awarded a contract for the erection of a foundry.

Erection of a modern foundry is being planned by the Rathbone Mfg. Co., Grand Rapids, Mich.

The Banner Gas Range Co., South Bend, Ind., has increased its capital from $75,000 to $100,000.

An addition is being erected at the plant of the St. Marys Foundry Co., St. Marys, O.

A new foundry building is being erected by the Pacific Brass & Steel Foundry, Portland, Oreg.

The plant of the Beaulieu Foundry, Nicolet, Que., recently was damaged by fire.

A. F. Wendling has the contract to erect a foundry addition for Russell & Co., Massillon, O.

J. A. Sevigny, Nicolet, Que., plans to erect a modern foundry building.

The pattern shop of the Gardner General Foundry Co., Gardner, Mass., recently was damaged by fire.

Erection of a foundry is contemplated by the Willys-Morrow Co., Elmira, N. Y.

Plant additions, including a foundry, will be erected by the Robbins & Myers Co., Springfield, O.

Kaufman Bros., Ashland, O., plan the erection of a small foundry and office building, 45 x 70 feet.

A foundry and machine shop will be erected at Williamstown, N. J., by the Pusey & Jones Co.

Dick Bros., Inc., 20 Penn street, Reading, Pa., is reported contemplating the equipping of a foundry.

New plant additions which are being completed will make the melting capacity of the Saginaw Malleable Iron Co., Saginaw, Mich., 160 tons a day.

Due to increased business the Western Malleables Co., Beaver Dam, Wis., has found it necessary to reopen its South street foundry.

Burnett & Crampton, Rigaud, Que., are having plans prepared for the erection of a foundry to have a capacity of 250 tons of castings a month.

W. A. Moine, architect, is preparing plans for the erection of additions to the plant of the International Malleable Iron Co., Guelph, Ont.

Erection of an addition, 54 x 100 feet, is contemplated by the Riverside Foundry Co., Wrightsville, Pa.

Bids are being taken for the erection of two plant additions, 85 x 100 feet and 43 x 65 feet, for the Sun Ray Stove Co., Delaware, O.

Bids are being taken for the erection of a foundry, 100 x 220 feet, for the Parkersburg Rig & Reel Co., Parkersburg, W. Va.

The Baltimore Car & Foundry Co., Curtis Bay, Baltimore, is reported having purchased property adjoining its plant.

Plans are being drawn for the erection of a foundry addition, 90 x 90 feet, at the plant of the E. H. Bardes Range & Foundry Co., Cincinnati.

The capacity of the foundry of the Wausau Foundry & Machine Co., Wausau, Wis., will be increased.

An increase in capital stock from $60,000 to $79,000 has been authorized by the stockholders of the Aetna Steel Castings Co., Cleveland.

The Sommer Adams Co., 2934 East Fifty-fifth street, Cleveland, will make alterations to its foundry and machine shop.

The Des Moines Foundry & Machine Co., Des Moines, Iowa, recently organized, will build a plant. Emil Schmidt is president of the company.

L. C. Gahbert and others of St. Joseph, Mo., have organized a company and will erect a malleable plant.

The Warman Brass & Aluminum Co., Cincinnati, recently was incorporated with $25,000 capital, by Roy Warman and others.

The Blackmer Pump Co., Petosky, Mich., will enlarge its plant by the erection of a foundry and other buildings.

An increase in capital from $75,000 to $125,000 has been authorized by the stockholders of the Pettigrew Foundry Co., Harvey, Ill.

Capitalized at $50,000, the Lima Brass & Iron Foundry Co., Lima, O., recently was incorporated by Joseph White and others.

Erection of an addition, 130 x 300 feet, is contemplated by the Ross-Meehan Foundries, Chattanooga, Tenn.

The Moore-Noble Foundry Co., San Francisco, recently was incorporated with $12,000 capital, by J. H. Moore, E. B. Noble and others.

The M. L. Oberdorfer Brass Co., 804 East Water street, Syracuse, N. Y., plans the erection of a foundry addition.

A part of the plant of the Clarksville Foundry & Machine Shops, Clarksville, Tenn., recently was damaged by fire.

Announcement has been made of the sale of the property of the Van Wie Pump Co., including a foundry, to the United States Hoffman Co. The for-

mer company, whose offices are at Syracuse, N. Y. plans to erect a new foundry and machine shop as soon as a site can be purchased.

Charles Cunningham, Bristol, Va., is organizing a company with $50,000 capital, to engage in the manufacture of steel castings.

Cribbon & Sexton, founders, Chicago, have let a contract for the erection of a plant addition, 88 x 122 feet.

An increase in its capital from $20,000 to $125,000 has been authorized by the stockholders of the Wadsworth Aluminum Co., Wadsworth, O.

Erection of an addition to its pattern shop, 30 x 80 feet, is contemplated by the Royersford Foundry & Machine Co., Royersford, Pa.

The Columbia Brass Foundry, 722 High street, Los Angeles, has been organized by P. N. Bailey, C. L. Draper and others.

The Shilling Foundry Co., Columbus, O., is reported contemplating the erection of an addition to its plant. Clarence Shilling is president.

A permit has been taken out by the Collinwood Foundry Co., Cleveland, to erect a foundry addition, 25 x 42 feet.

John Dedier, proprietor of the Rhinelander Iron Works, Rhinelander, Wis., plans the erection of a new building for a molding department.

Steel & Radiation, Ltd., Toronto, Ont., is having plans drawn for the conversion of a factory building into a foundry.

The Ruhl Malleable Iron Co., Detroit, plans the erection of a plant addition and chipping room, 144 x 232 feet.

Among the recent Ohio incorporations is that of the Sterling Foundry Co., Wellington, O. The company, which is capitalized at $150,000, was incorporated by R. E. Clisby and others.

Capitalized at $5000, the Kent Foundry Co. recently was incorporated at Grand Rapids, Mich., by Harm Engbors, William H. Duffy and Lewis E. Davis.

Frank L. Bridges and Peter Lamberius were named among the incorporators of the Acme Aluminum & Brass Works, Indianapolis, which was recently chartered with $40,000 capital.

Construction of a foundry, 100 x 150 feet, is being planned by the Great Falls Iron Works, Great Falls, Mont. Electrically operated cranes will be installed.

The Southern Pipe & Foundry Co., Knoxville, Tenn., recently was incorporated with $75,000 capital, by F. S. Mead, J. G. Simpson, T. S. Webb, R. W. Brown and Malcolm McDermott.

Incorporation papers have been filed with the secretary of state by the Ypsilanti Foundry Co., Ypsilanti, Mich., which was recently organized with $100,000 capital.

Additions being made to the plant of the Fulton Foundry & Machine Co., Cleveland, will increase its capacity 50 per cent. The extensions include a machine shop, 80 x 160 feet.

The Fate-Root-Heath Co., Plymouth, O., is erecting a foundry, 200 x 300 feet, and a power house and office building. All contracts for equipment have been let.

Erection of a reinforced concrete foundry building is being rushed to completion for the Keystone Foundry Co., Plymouth, Ind. J. E. Fogarty is president of the company.

The Jaeschke Bros. Foundry Co., Thirty-first and Locust streets, Milwaukee, will start work shortly on the erection of plant additions, including a foundry extension, 90 x 150 feet and a coreroom, 50 x 100 feet.

An increase of 100 per cent in the capacity of the A. E. Martin Foundry Co., 705 Park street, Milwaukee, is provided by plans for new construction, which include a new core room and molding floor, 80 x 144 feet.

The South Beloit Stove & Mfg. Co., Beloit, Wis., recently was incorporated with $75,000 capital to take over the business of Charles H. Burgess & Son, and engage in the manufacture of gray iron castings, stoves, etc.

The W. C. Hunt Mfg. Co., Ltd., Toronto, Ont., recently was incorporated with $40,000 capital to carry on business as iron and brass founders, by William C. Hunt, 59 Paton road, A. C. Crocker, 322 Symington avenue, and others.

Bids will be taken shortly by the Bridgeport Brass Co., Bridgeport, Conn., for the erection of a foundry.

Work on the erection of a $500,000 plant for the Adirondack Steel Foundries Corp., Co'onie, N. Y., has been started.

John F. Henry, 320 Eighth avenue, Wilmington, Del., has plans for the erection of an addition to his foundry.

An addition now being erected at the plant of the Standard Brass Foundry Co., Cleveland, when completed, will house the offices, pattern storage, shipping and cleaning departments. The building now being used as a shipping department will be remodeled as an extension to the molding room.

The Great Lakes Malleable Co., Milwaukee, has awarded contracts for remodeling work and the erection of additions to its plant at 710-716 Reed street, formerly occupied by the Maynard Steel Foundry Co. The new work includes a building, 60 x 65 feet, to be used as an annealing shop. Ray F. Ethier is secretary.

Erection of plant extensions, which include a foundry, 160 x 300 feet, and an engineering building, 130 x 275 feet, has been started at the plant of the Kohler Co., Kohler, Wis.

Ground has been broken at Janesville, Wis., for a foundry for the production of tractor castings for the Samson Tractor Co., a division of the General Motors Corp. The foundry group will include coreroom, sand storage building and pattern shop and will cover an area 330 x 530 feet. Frank D. Chase, Inc., Chicago, is engineer in charge.

The Industrial Steel Casting Co., Toledo, representing a reorganization of the Taylor Coupler & Steel Castings Co., has started on the reconstruction of a building for its increased needs. When completed the work will provide space 120 x 180 feet in addition to the office. Four electric furnaces for producing steel for automobile castings, etc., will be installed. L. S. Dukes is president.

New Trade Publications

FOUNDRY EQUIPMENT.—Pouring devices, molding machines, squeezers, and jolting machines are described and illustrated in a 4-page circular being distributed by the Arcade Mfg. Co., Freeport, Ill.

HOSE COUPLING.—A newly designed hose coupling is described and illustrated in a folder prepared by the Independent Pneumatic Tool Co., Chicago. This coupling can be disconnected instantly by a straight pull on the knurled sliding sleeves. The bevel jaws and locking shoulders are heavy, with large bearing surfaces, and according to the folder, cannot break, jar or work loose. The folder also describes a clamp, designed especially for hose couplings.

STEEL LUMBER.—A reference handbook, which should be of especial use to engineers, architects, etc., for their use in designing various types of building construction, is being circulated by the National Pressed Steel Co., Massillon, O. The book is 72 pages in length and is cloth bound. The data given covers a system of construction in steel lumber with structural steel and other materials. Complete specifications of such construction, properties of steel lumber sections, tables of safe loads, construction details and other designing data are clearly illustrated and described.

FOUNDRY FLASKS.—The Truscon Steel Co., Youngstown, O., is distributing a 4-page circular in which pressed steel foundry flasks are described and illustrated. The ribs and flanges of these flasks extend the full depth around the corners without buckling or cutting away the metal. The meeting parts are welded. The pinholders are of malleable iron and are securely riveted to the flask. The flange on the filling side is turned outward so as not to interfere with ramming the molding sand, or hold it when shaken out. The flange on the bottom is turned inward, holding the sand in place when the flask is lifted. One page of the folder describes and illustrates a steel platform for use with lift trucks.

PIPE CUTTER.—The Fox Machine Co., Jackson, Mich., is circulating a 4-page folder in which it describes and illustrates its No. 10 pipe cutting machine. The base of the machine is of a cabinet type and contains a tank for the cutting compound, which has a capacity of 1½ gallons. The top of the machine is cast with flange around the outer edge and there are pads on the surface to which are bolted the brackets for supporting the various parts of the machine. The cutter arm is fulcrumed in heavy bearings, which also form the bearing for the main driving shaft. All gears are encased. Cutter disks are of tool steel, are 6 inches in diameter and means are provided for grinding the disk while it is in cutting position in the machine. Three different sized pipe supports are furnished. The position of the cutter can be raised or lowered by turning a crank which extends through the front of the machine. A stop gage, which is adjustable for cutting any length of pipe, forms part of the equipment.

PRODUCTION RECORDS.—The Pelton Steel Co., Milwaukee, is circulating a 16-page booklet in which colored charts showing the production records of the company during 1916, 1917 and 1918 are given. One chart shows that during 1916 the company's average daily production was 2.34 tons and in 1918 the production had jumped to 11.72 tons. Another chart compares the number of shipments with the number of scrap tons returned. In 1916 there were 471.20 tons shipped while of this amount 5.83 tons or 1.24 per cent returned. In 1918 shipments totaled 3328.58 tons and of this amount 93.11 tons or 2.79 per cent were returned. Other charts given include, combination scrap record; electric furnace heat record and typical customers' shipments and returned scrap for the year 1918.

STEEL CASTINGS.—A large cardboard-bound book of 62 pages, containing a pictorial portrayal of the plants at Attica, Ind., and Murphysboro, Ill., of the Harrison Steel Castings Co. and the National Car Coupler Co., and a brief description of their products, is being circulated. Printed on heavily coated stock and well illustrated, the book is a most attractive trade publication. A number of the illustrations are in color. The first part of the book is devoted to a brief history of steel; then follows the history of both companies. This is accompanied by views of the plant, including the interior of the pattern shop, the foundries, the open-hearth furnaces at the Attica plant, the laboratory and other departments. The latter part of the book is devoted to a description of castings made by the companies.

LOCOMOTIVE CRANE.—The United States Crane Co., Chicago, in bulletin 190, recently published, describes and illustrates its line of locomotive cranes, for grab-bucket, hook-block or magnet service. Some of the specifications of these cranes are: Working weight, 159,000 pounds; shipping weight, 120,000 pounds; ballast required, 30,000 pounds; lower frame; 18-inch I-beam with cast steel brackets for spur gear drive mechanism; rotation gear and roller path; rotation rollers; rotating frame; side housings; engines are of the vertical type, double, 16-inch cylinder diameter with 10-inch stroke; boilers of the vertical type, 54-inch diameter, 9½ feet high, 125 tubes, 2½ inches in diameter; steam pressure 125 pounds to the square inch; water tank capacity, 500 gallons and coal bunker capacity, 2000 pounds. The cranes have a drawbar pull of 9000 pounds maximum, a hoisting speed of 280 feet per minute and have lifting capacities, without track clamps or outriggers, of 20 tons at 15-foot radius and four tons at 50-foot radius.